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CONTENTS OF PREVIOUS NUMBERS

JANUARY, 1923. NUMBER 1

Physiology of Exercise in Children. Part 1. A Study of Normal Children of School Age. Max Seham, M.D., and Grete Egerer-Seham, Ph.D., Minneapolis.

Chemical Studies of the Blood of Mother and Fetus. Marion G. Howe and Maurice H. Givens, Pittsburgh.

The Treatment of Flat Warts by the Internal Administration of Mercury. Howard Fox, M.D., New York.

Comparison of Diphtheria Immunity in the Mother and in the New-Born. H. O. Rub, M.D., and J. E. McClelland, M.D., Cleveland.

Celiac Disease. Rood Taylor, M.D., Minneapolis.

The Colloidal Gold Reaction in Acute Poliomyelitis. Joseph C. Regan, M.D.; Abraham Litvak, M.D., and Catherine Regan, M.D., New York.

FEBRUARY, 1923. NUMBER 2

The Influence of Growth on the Basal Metabolism of Children. G. B. Fleming, M.D., Glasgow, Scotland.

Neuropsychiatric Sequelae of Acute Epidemic Encephalitis in Children. Franklin G. Ebaugh, M.D., Philadelphia.

Acute Hemorrhagic Encephalitis: Report of Case Following Scarlet Fever. John A. Toomey, M.D., Leon H. Dembo, M.D., and Guthrie McConnell, M.D., Cleveland.

Intraperitoneal Transfusion with Citrated Blood; An Experimental Study. David M. Siperstein, M.D., Minneapolis, and J. Martin Sansby, M.D., St. Paul.

Congenital Malaria: Report of a Case in Colorado. R. P. Forbes, M.D., Denver.

The Excretion of Foreign Protein in Human Milk. Harold C. Stuart, M.D., Boston.

Oxygen Therapy in Premature Babies with Anoxemia. Harry Bakwin, M.D., New York.

Toxemia of Severe Superficial Burns in Children. Bruce Robertson, M.B. (Tor.), and Gladys Boyd, M.B., Toronto, Canada.

Progress in Pediatrics:

A Review of the Literature on the Blood and Blood Diseases of Infants and Children for the Last Four Years (1918-1921). Louis Webb Hill, M.D., Boston.

MARCH, 1923. NUMBER 3

The Value of Basal Metabolism in the Diagnosis and Treatment of Cretinism. Fritz B. Talbot, M.D., and Margaret E. Moriarty, Boston.

The Bacteriology of the Urine in Acute Nephritis in Children. Lewis Webb Hill, M.D., Emily F. Hunt, A.M., and Elsie W. Brown, A.B., Boston.

Intraperitoneal Transfusion with Citrated Blood: A Clinical Study. David M. Siperstein, M.D., Minneapolis.

Polycystic Disease of the Kidneys. Report of Case in an Infant. Abraham Tow, M.D., New York.

Lead Poisoning in Infancy. L. Emmett Holt, Jr., M.D., Baltimore.

Types of Organism Found in a Series of Tuberculous Children. J. Keith Gordon, M.D., and Elsie W. Brown, B.Sc., Boston.

Calcium Absorption in Children on a Diet Low in Fat. L. Emmett Holt, M.D., and Helen L. Fales, New York.

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BRAIN TUMORS IN YOUNG CHILDREN

A CLINICAL AND PATHOLOGIC STUDY *

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Among 4,563 necropsy records at the Babies' Hospital, there are listed nine cases of neoplasm of the brain. While it is true that the brains of all these infants were not examined, because permission was not obtained, there is no instance in which there was a failure to examine the brain when a neoplasm had been suspected. This makes an incidence of 0.2 per cent., which is less than the 1 per cent. recorded for the occurrence of brain tumors among adults. There were two girls and seven boys, and their ages ranged from 2 weeks to 3 years.

The results of a study of seven of the cases are recorded in this paper. Five neoplasms were located in the cerebellum, constituting infratentorial tumors, and two in the cerebrum, constituting supratentorial tumors.

CEREBELLAR (INFRATENTORIAL) TUMORS

All five infratentorial tumors involved the vermis and extended into one lobe of the cerebellum, compressing the other lobe; all had distorted the medulla; three (Cases 1, 5 and 7) had compressed the upper cervical segment of the spinal cord; one (Case 2) had compressed the pons as well as the medulla; one neoplasm (Case 5) had extended into the pons and was accompanied by a cyst in the fourth ventricle (Dr. J. R. Hunt [1]), and another (Case 4) involved one of the cerebellopontile peduncles. None gave rise to metastasis in the other organs.

The tumors were all large, measuring from 4 by 3.5 to 9 by 10 cm. in diameter. They were situated under the pia, which was deep red or reddish blue over the growth. They were very vascular, containing small hemorrhages and areas of necrosis. One (Case 2) contained a small cyst as a result of softening.

Hydrocephalus was associated with all five tumors, but it was not excessive in any case. In only one instance (Case 1) were the cerebral

* Received for publication, Feb. 20, 1923.
* From the Babies' Hospital.
1. Hunt, J. R.: Am. J. M. Sc. **127**:504, 1904.

convolutions flattened and the cerebral cortex thinned. In the other four, the cortical substance of the cerebral hemispheres was not thinner than normal, and the ventricular distention was moderate in amount. The hydrocephalus resulted from the closure of the foramen of Magendie by pressure of the tumor on the roof of the fourth ventricle. The meninges were never the seat of neoplasmic infiltration.

Histologically, these five infratentorial neoplasms were gliomas of the astrocytoma type.

These gliomas apparently began in the inferior vermiform process and extended anteriorly, upward and laterally, but more to one side than to the other; that is, both cerebellar lobes were not equally involved. Usually one lobe was infiltrated by the growth and the other was only compressed. Anteriorly, the tumors advanced to the anterior surface of the cerebellum and thus to the roof of the fourth ventricle; upward they spread to the middle cerebellar peduncles or to the pons. As a result of the direction of growth, the tumors under consideration pressed on the uninvolved portion of the cerebellar hemispheres and peduncles, on the pons, medulla and first cervical segment of the spinal cord. Secondarily, ventricular distention exerted pressure on the cerebral hemispheres, already compressed by the increased intracranial pressure resulting from the mechanical presence of the tumor. The cranial nerves were distorted and compressed as a result of pressure exerted by the tumor on the pons and medulla.

CEREBRAL (SUPRATENTORIAL) TUMORS

The two supratentorial growths were dissimilar in location and in structure.

One (Case 3) involved the following basal ganglions: the corpora striata and optic thalami, and the corpora quadrigemina. The left corpus striatum and the left optic thalamus were larger than the corresponding ganglions on the right. In this case the hydrocephalus was extreme, resulting in a compression of the cerebral cortex to a diameter of 3 mm. over several gyri in both hemispheres. The pressure of the growth on the third ventricle and on the foramina of Monro caused this distention of the lateral ventricles. The aqueduct and the fourth ventricle were not enlarged. A curious phenomenon in this case was the presence of an enormously dilated cisterna magna, making a bag of fluid, 4 cm. in diameter, on the under surface of the cerebellum. This must have been due to the gradual accumulation (by secretion) of fluid in the fourth ventricle and its entrance into the cisterna through the open foramen of Magendie. It was prevented from entering the cerebral subarachnoid space because this space was obliterated by the pressure of the large cerebral hemispheres. Histologically this tumor was a glioma (astrocytoma).

The second cerebral or supratentorial growth (Case 6) occurred in such a young child that the probability of its congenital origin can scarcely be doubted. The points of interest in the case are these: the age of the infant; the rapid enlargement of the head; the cerebral hernia after spontaneous rupture of the scalp and membranous left frontal bone; the extensive involvement of the left cerebral hemisphere, so that the point of origin could not be definitely determined, and the fact that the cranial enlargement was due less to the hydrocephalus

TABLE 1.—FINDINGS IN SEVEN CASES OF BRAIN TUMOR

Approximate Age of Child at Onset of First Symptom	First Symptoms to Appear (Parents' Statement)	Approximate Duration of Disease (Onset to Death) Months	Sex*	Location of Tumor	Remarks
Case 1 R. P. 22 mos.	Stumbling gait and drowsiness	7½	♂	Glioma of medulla, pons, and vermiform process of cerebellum	Fontanel closed on admission to the hospital; no change in fontanel before death
Case 2 A. S. 35½ mos.	Vomiting	2½	♂	Glioma of cerebellum	Fontanel closed on admission to hospital; fontanel open before death
Case 3 F. D. 16¾ mos.	Paralysis of right arm and right leg	13	♂	Glioma of optic thalamus and corpus striatum	Fontanel closed on admission to hospital; fontanel open before death
Case 4 R. D. 12 mos.	Hydrocephalus	4	♂	Glioma of cerebellum	Fontanel open on admission to hospital
Case 5 W. J. 8 mos.	Vomiting	5½	♂	Glioma of cerebellum and medulla	Fontanel closed on admission to hospital; no change in fontanel before death
Case 6 S. K. 2 wks.	Hydrocephalus	1½	♂	Glioma-sarcomatodes of left cerebral hemisphere, probably beginning in left frontal lobe	Fontanel open on admission to hospital
Case 7 R. S. 9 mos.	Vomiting	1¼	♀	Glioma of the cerebellum	Fontanel open on admission to hospital
Average 15 mos.		Average 5 mos.	6 male 1 female		

* In this column, ♂ represents male and ♀ female.

in the right hemisphere than to distention of the left cerebral hemisphere with new growth. Histologically this tumor was a glioma sarcomatoides (Borst) or gliosarcoma.

Only one of the seven children presented a malformation in another organ than the brain. In Case 3, in which the boy had a glioma which involved the basal ganglions, there was also a horse-shoe kidney.

The average age of the children reported in this paper is about 15 months (Table 1). This places the time of the appearance of the tumors in this series of cases in the period of infancy. It is discon-

certing to the clinician to discover at necropsy that puzzling symptoms shown by active infants have been due to the presence of tumor growth. There are certain conditions in infancy that may, in part, account for the delay in the appearance of symptoms resulting from the presence of a tumor in the brain. Infancy is the period of rapid growth and of adjustment to new environment. In this respect the infant differs from the adult. It must be remembered that the skull of a growing infant is distensible. Therefore, a growing brain and a distensible skull present two conditions which may delay the manifestations of a tumor growing in an infant's brain. From these statements it may be seen that in infancy one is confronted by a physiologic condition (a growing brain) and a mechanical condition (a distensible skull).

Infancy also presents a difficult problem resulting from the fact that an infant cannot give information about his own feelings. Even children of 2 or 3 years of age (Cases 1 and 2) are too young to report accurately subjective feelings. The first knowledge that there is anything wrong with a child comes from the observations of the parents or attendant. An adult will indicate that there is something wrong with him by declaring that he has a persistent headache, or that he feels nauseated, or that he has a dizzy sensation, or an unusual sensation in some part of his body. The evidence which an adult will give to a physician of such a disturbance an infant does not give. The result of this is that a new growth in the brain may reach a considerable size before it gives symptoms to which one's attention is directed. In other words the help given by subjective symptomatology is lacking in infancy.

Objective information derived from tests for disturbance of sensation are particularly inapplicable to children of the age reported in this paper, i. e., about 15 months. One is confronted, then, by this twofold problem in the interpretation of brain tumors in infants: First, a child has a new growth in the brain; it is not of an age to complain of its subjective feelings nor able to give early information that something is wrong; secondly, because of its age there is a physiologic condition (a growing brain) as well as a mechanical condition (distensible skull) which may delay the appearance of objective evidence which is so essential as a starting point for searching out the cause of any abnormal disturbance.

Early objective information given by motor disturbances apparently appears at a time when the tumor has grown to a considerable size. In the case of cerebellar tumors information derived from disturbance of gait is not available in young infants. The infants classified as Cases 3, 4 and 5 of this series were not yet walking. If an

infant is learning to walk the superimposed stumbling gait from a cerebellar tumor would be difficult to differentiate from his learning-to-walk gait.

The earliest symptoms of brain tumor are those reported by parents or nurses. A study of these early symptoms in connection with pathologic findings in the cases in this series shows that in all probability the tumors had grown to a considerable size before giving physical signs.

The first symptom in Case 2 which called attention to the fact that there was something wrong was internal strabismus of the right eye and headache. The cerebellar tumor (compare necropsy report of Case 2) had grown to such a large size that it had distorted the pontine-medullary border. This distortion had compressed the right sixth nerve, causing the internal strabismus. At this stage of its growth the tumor was probably inoperable, and it was only when the tumor had reached this inoperable size that unusual symptoms were noticed.

The first symptom noticed in Case 3 was paralysis of the right arm and right leg. In this infant the tumor, starting in the left optic thalamus and corpus striatum, had invaded the left internal capsule. This infiltration had interrupted the conduction from the arm and the leg centers giving, in the paralysis, the first evidence of intracranial disease. This information, however, came at a time when the tumor must have been of considerable size and when operation for its removal would, probably, not be possible.

The first symptom in Case 4 to attract the attention of the parents was an increase in the size of the head. This was first noticed when the child was about 12 months old. He was brought to the hospital at 16 months of age. The enlargement of the head at 12 months was the result of accumulation of fluid in the ventricles. The tumor in the cerebellum had grown sufficiently in size to cause pressure on the roof of the fourth ventricle and close the foramen of exit. This case illustrates again the difficulty of making an early discovery of a new growth in the brain, since apparently in many instances there are no symptoms to attract the attention of the parents in the early stages of the growth of the tumor. This infant was not walking nor standing, and the characteristic cerebellar symptoms were not applicable.

The first symptom in Case 5 to attract attention was vomiting. The infant began to vomit at about 8 months of age. He vomited about every other day for two or three weeks, and then the vomiting became more frequent, two or three times a day. There was nothing unusual in the character of the vomiting. It was not noticed to be forcible. Vomiting is such a common symptom of digestive trouble that it is not surprising that its association with brain tumor should be overlooked in an infant of 8 months of age. Indeed, there is no evidence that in this infant the vomiting was the result of intracranial

trouble. At 11½ months of age drooping of the right eyelid was noticed. The time between the vomiting and the ptosis was about three and one-half months. When the child was brought to the hospital, at 13½ months, the parents asked that it be admitted because of failure to gain in weight. The vomiting and the ptosis had apparently not worried them. The time between the onset of the vomiting and the entrance to the hospital was about five and one-half months. The baby died the same day on which he was admitted.

The necropsy report shows that by the time the baby was admitted to the hospital the tumor was probably inoperable. It is doubtful even whether a physciian would have been led to investigate the presence of a brain tumor when the baby began to vomit at 8 months. Furthermore, there is no evidence to prove that the baby vomited at that time because it had a brain tumor. The first significant symptom was the ptosis of the right eyelid with retraction of the mouth, and the baby lived only a month and a half after this was noticed. In all probability by 11½ months the tumor was too large to be removed. There is every reason to believe that, in infants of this series, the brain tumor had grown to a considerable size before it gave symptoms that attracted attention.

Cases 1, 6 and 7 have not been referred to in this connection; they only furnish added information to substantiate the foregoing statement.

It is unnecessary to refer in detail to the symptoms of brain tumor, after the new growth has reached a size sufficient to cause physical signs that alarm the parents, in the infants reported in this paper. These symptoms are comparable to those in adults; for example, spasticities, increased reflexes, focal paralysis, etc. The nervous symptoms have been arranged in the approximate order of appearance following the case history. It may be of interest to call attention to the appearance and disappearance of reflexes which some of the cases show. This may possibly be explained by changes of the blood pressure in the brain or in the tumor itself, or by the occurrence of hemorrhages in the tumor resulting in variation in its size. Such changes in the size would account for pressure symptoms when the tumor is larger, and relief of such symptoms when the tumor is smaller.

Especial interest attaches to Case 6. This infant's head began to enlarge when it was 2 weeks old. The necropsy showed, four weeks later, that the enlargement of the head must have been due to the size of the growth in the left cerebral hemisphere and, secondly, but in a less degree, to the accumulation of fluid in the right lateral ventricle through pressure of the tumor on the third ventricle. Undoubtedly, the new growth was of congenital origin. According to Virchow [2] hyperplastic gliomas are occasionally congenital.

2. Virchow, Rudolph: Die Krankhaften Geschwülste **2**:148, 1864-1865.

Two symptoms commonly associated with brain tumor are vomiting and convulsions. Vomiting occurred in three instances (Cases 2, 5 and 7) as an early symptom. The character of the vomiting was not described as projectile except in Case 6. Vomiting was of the kind commonly seen in cases of disturbed digestion. While the patients were under observation in the hospital, none presented unusual frequency of vomiting, nor was the vomiting of an explosive type.

Convulsions occurred in only one instance (Case 1) in this series. This child had a convulsion a few hours before death. As convulsions in brain tumor are frequently mentioned in textbooks on diseases of infants and children, it seems desirable to call attention to their

TABLE 2.—Results of Examination of Spinal Fluids in Seven Cases

	Amount, C.c.	Appearance	Pressure	Cells	Globulin	Sugar
Case 1:						
10/ 4/14.....	30	Clear	Increased	10 per c.c.	0	0
10/14/14.....	..	Clear	Increased	—	—	—
12/ 8/14.....	15	Clear	Normal	Normal number	0	—
3/11/15.....	30	Clear	—	—	—	—
Case 2:						
7/ 7/15.....	27	Clear	Increased	—	—	—
7/ 8/15.....	7	Clear	No increase	96 (polymorphonuclears, 19%; lymphocytes, 81%)	—	—
7/13/15.....	20	Clear	No increase	7 (polymorphonuclears, 0; lymphocytes, 100%)	+	—
7/20/15.....	15	Clear	Increased	10 (lymphocytes, 100%)	+	—
7/23/15.....	20	Clear	No increase	3 (lymphocytes, 100%)	0	+
7/29/15.....	15	Clear	Increased	5	0	—
Case 3:						
12/19/16.....	5	Clear	Increased	5	+	—
12/22/16.....	5	Clear	No increase	Few scattered red cells	±	+
10/29/17.....	15	Clear	No increase	9	—	0
10/30/17.....	25	Clear	Slight	21 (lymphocytes, 100%)	+	0
11/ 2/17.....	20	Clear	Slight	15	+	0
Case 4 (none)						
Case 5.....	15	Clear	—	Polymorphonuclears, 1; lymphocytes, 12		
Case 6:						
1/21/14.....	—	Yellow	Increased	Polymorphonuclears, 63%; lymphocytes, 37%	—	+
Case 7:						
9/23/17.....	—	Clear	Increased	24 (lymphocytes, 100%)	—	0
9/26/17.....	—	Clear	—	90 (polymorphonuclears, 9%; lymphocytes, 91%)	—	+

nonoccurrence in the infants reported in this paper, whose average age was about 15 months.

Infrequency of vomiting and infrequency of convulsions in the infants of this series may be explained by the gradual increase in intracranial pressure and by the extreme adaptability of the young brain tissue to pressure gradually applied. Given this gradually increasing pressure in a space which is distensible, that is, in a partially opened cavity, the skull, it seems reasonable to assume that the effects of compression expressed by vomiting and convulsions are delayed.

The spinal fluids (Table 2) obtained on lumbar puncture in these seven cases varied in amounts from 5 to 30 c.c. The pressure was increased only when the infants were seen early (Case 1 and 3).

Later in the disease the pressure was not increased. The fluid was clear and colorless, except in one instance (Case 6), when it was yellow. The cells were increased in only one instance (Case 6). In the other six cases they varied in number between 5 and 24. Globulin was increased only in Case 6, in which the fluid was yellow and the cells were increased in number. The xanthochromia in the spinal fluid of this case resulted from the vascularity of the tumor and the trauma incident to the cerebral hernia.

Case 5 illustrates a confusion which might arise in determining localization of cerebral tumors. The neoplasm in this infant occupied the right cerebral hemisphere and the right cerebellopontile peduncle. It was so large that it disturbed the pons and medulla and pushed them against the border of the foramen magnum. The effect of this was to compress the trunk of the left facial nerve. This pressure would explain the left-sided facial paralysis which was noted on admission. Such paralysis would be explained by a tumor in the right cerebellar hemisphere.

REPORT OF CASES

CASE 1.—*History.*—R. P., boy, aged 2 years, was admitted to the Babies' Hospital, Sept. 29, 1914, because of a stumbling gait. He was the only child. The parents were well. There was no history of tuberculosis or syphilis. The birth had been normal. He was nursed for fifteen months, and had received a mixed diet since. He had never been particularly vigorous, although he had had no acute illness. About two months previously it was first noticed that he could walk only a short distance without stumbling. This difficulty had steadily increased until at the time of admission he could only occasionally cross a room without falling. Listlessness and a desire to sleep a great deal of the time had been associated with the stumbling gait since its onset. The appetite had always been good. The stools were regular. There was no pain.

Physical Examination.—The child was a well nourished and well developed white boy. He did not look sick. The anterior fontanel was closed; and the sutures were ossified. The skull bones were firm. The pupils were equal and reacted to light. The tonsils were enlarged, and the adenoids hypertrophied. There was no rigidity of the neck. The knee-jerks were exaggerated. There was double ankle clonus. The gait resembled that of a drunken man. The child fell to one side as he walked. He lifted his feet high and swayed from side to side. The head measured 51 cm. (20⅛ inches); the chest, 51 cm. (20⅛ inches); the abdomen, 47 cm. (18½ inches), and the height was 89 cm. (35 inches).

Course in Hospital.—October 5, both disks were blurred and the margins were indistinct. There was double papillitis. The knee-jerks were not obtained; there was no ankle clonus.

October 10, the knee-jerks were present. The disposition was good, and the child was happy.

October 14, slight nausea was present, probably from the ingestion of potassium iodid (30 grains a day). He had a mania for chewing rubber. He had eaten the rubber of one percussion hammer and had gnawed the rubber of a stethoscope. He vomited five times between September 29 and October 14, when he went home.

October 14 to 17, the child was at home.

Second Admission.—October 17, he was readmitted because of diarrhea. There was no change in the nervous symptoms compared with October 14 except that double ankle clonus was obtained.

October 27, there was no vomiting. The disposition was good. There was slight incoordination of the right hand noticed for the first time. He could not stand without support, and he reeled to one side.

November 2, papillitis was increasing in both eyes.

November 7, knee-jerks were not obtained. There was no ankle clonus.

November 11, knee-jerks were present. There was no ankle clonus. A coarse tremor of the right hand was apparent when he reached for objects; there was incoordination of the right hand.

November 28, papillitis was increasing.

December 3, there was persistent drowsiness all day; it was difficult to arouse him. He wakened for a few minutes, said a few words, and went to sleep again. The pulse was irregular. He refused food.

December 7, right facial paralysis developed. There was internal strabismus in the left eye. He was stuporous most of the time. A cracked-pot sound was elicited over the cranium (demonstrated by Dr. J. Ramsey Hunt).

December 8, the anterior cervical glands were swollen and sensitive.

October 17 to December 8, he vomited ten times.

December 14, his mind was clear; he was bright and happy.

December 20, there was slight drooping of the right corner of the mouth, internal strabismus in the right eye, coarse tremor of the right arm and hand on attempt to grasp objects. The knee-jerks were sluggish.

December 26, knee-jerks were not obtained.

January 16, the temperature ranged between 102 and 104 F. from January 6 to January 16, owing to double purulent otitis media and bronchopneumonia. The slight facial paralysis persisted; the knee-jerks were difficult to obtain. Double ankle clonus was marked.

January 18, the eyes were examined. The disks were pale; the outlines, very indistinct; the vessels, not enlarged, and there was beginning atrophy of the disks.

January 20, there was no suggestion of facial paralysis. He could not stand alone or walk. There was slight optic atrophy, no vomiting, no evidence of headache. The knee-jerks were hard to obtain.

February 7, he sat up in bed the greater part of the time, and was bright and happy. There was no evidence of facial paralysis.

February 17, he began to vomit. This was accounted for by potassium iodid, 12 grains a day which was being given. He seemed slightly stronger on his legs when supported.

February 20, he vomited two or three times a day. He seemed to feel bad and was contented to stay in bed. He coughed, and the entire left lower lobe was filled with fine crackling râles.

February 27: Vomiting was projectile February 26 for the first time. The child had failed rapidly; he looked pale, thin and unhappy. He was fretful and irritable. Ophthalmoscopic examination revealed cloudiness and blurring of the disks. The vessels were enlarged and tortuous. A decompression operation was performed with puncture of the corpus callosum.

February 28, he talked brightly and intelligently and wanted to sit up.

March 2, there was noticeable strabismus. There had been no vomiting for two days.

March 5, there was no vomiting. He was less drowsy and stuporous; he played with his toys and talked brightly. Strabismus was still quite marked; more so in the right eye. The right eye was wide open, and the left lid drooped. There was slight right facial paralysis.

March 9, he was apathetic and stuporous. He sat in a chair or in bed most of the time with his eyes half closed. He answered questions slowly as if he

did not understand. Articulation was indistinct. Ptosis of the left lid was marked. He vomited yesterday for the first time since February 27. Papillitis had entirely disappeared in the right eye; nearly so in the left eye. There was moderate atrophy of both disks.

March 11, he had been markedly drowsy for two days. There was utter muscular relaxation at present. The knee-jerks were increased, more so than at any time since admission. Ankle clonus was quite marked.

March 12, 12:30 p. m., coma had been complete in the morning. A hernia about the size and shape of a peanut was present at the site of the head operation. The knee-jerks were exaggerated. There was marked ankle clonus. A convulsion occurred early in the morning, the first since admission. He refused food. At 2 p. m. a cyanotic attack occurred. Color gradually returned. The reflexes were gone. Respiration was slow and shallow, about 8 per minute. He died at 2:30 p. m.

Necropsy Findings.—March 13, 1915: The body was that of a small and fairly well nourished boy, aged 3½ years. The head was large and square.

TABLE 3.—RESULTS OF LABORATORY EXAMINATIONS IN CASE 1

Spinal Fluid	Oct. 4, 1914	Oct. 14	Dec. 8	March 11, 1915
Amount	30 c.c.	—	15 c.c.	30 c.c.
Appearance	Clear	Clear	Clear	Clear
Pressure	Increased	Increased	Normal	—
Cells	10 per c.c.	—	Normal no.	—
Globulin	None	—	None	—
Fehling's test	Negative	—	—	—

Wassermann test, negative; Pirquet test, negative; Eye grounds: Oct. 5, 1914, both disks blurred and margins indistinct; double papillitis. Nov. 2, 1914, papillitis increasing. Jan. 16, 1915, disks pale, outlines very indistinct; beginning of atrophy of disks. Feb. 22, 1915, cloudiness and blurring of disks; vessels enlarged and tortuous. March 9, 1915, papillitis had entirely disappeared in right eye, nearly so in left; moderate atrophy of both disks.

There was a healed round area near the median line, in the right parietal bone, from which a button had been trephined. When the calvarium was removed, adhesions were apparent around this spot, but there was no recent inflammatory exudate on the meninges. The superior longitudinal sinus was quite empty; the lateral sinuses contained fluid blood.

Both cerebral hemispheres showed flattening of the convolutions. The lateral ventricles were very much dilated, contained 400 c.c. of clear fluid, and measured 14 by 8 cm. The optic tracts were flattened, as were also the olfactory nerves. The cerebellum appeared wider than normal, owing to the enlargement of the vermis, which was very firm in its posterior half, and gave evidence of fluctuation anteriorly. On section, this fluctuation was found to be due to the dilatation of the fourth ventricle, which measured 3.5 by 2 cm. The tumor was 4 cm. wide and equally long. It occupied the inferior vermiform process and the roof of the fourth ventricle, which, in consequence, was greatly thickened and distorted. The floor of the ventricle was infiltrated with gray, translucent, gliomatous material. The aqueduct of Sylvius and the third ventricle were dilated. The pons was larger than normal because the growth had extended into its lower portion.

The two cerebellar hemispheres were equally compressed by the neoplasm. In the median line the substance of the superior vermiform process was only 8 to 10 mm. in depth, and in this region the neoplasm could be raised or shelled from its bed over an area of about 2 cm. Beyond this, however, in the right cerebellar hemisphere the tumor was growing into the cerebellar

substance and was not removable. The middle cerebellar peduncles were compressed but not infiltrated by the new growth. The upper segment of the cervical cord was compressed.

Anatomic Diagnosis: Subpial neoplasm of the cerebellum, involving the vermis, right cerebellar hemisphere, medulla and pons; compression of both cerebellar hemispheres, medulla and first cervical segment of the spinal cord; hydrocephalus; trephine wound in skull.

Microscopic Examination.—The cells composing the growth were rather small. They had a comparatively large nucleus, and protoplasmic processes or fibrils were demonstrable in many. The processes ramified between and to those of other cells and were more numerous in some fields than in others. There were spindle cells between the round ones. In some fields these were numerous and in other fields they were few. With the (immersion) high power, the round cells were found to be chiefly star shaped. Beyond the tumor, the cerebellar tissue was edematous.

Diagnosis: Glioma (astrocytoma).

CASE 2.—A. S., boy, aged 3 years, was admitted to the Babies' Hospital, July 6, 1915, because of internal strabismus of the right eye, and headache of about two weeks' duration. The father and mother were both healthy. The baby had been breast fed and had thrived. He had whooping cough six weeks before admission. He had been constipated since birth. He had had nosebleed three weeks previously. The present illness had begun about two weeks before admission. He vomited once a day; the right eye turned in, and he had headache. He had been drowsy for one week, and this had been the more noticeable the last two days. The breathing had been irregular for the last three or four days. He had suffered from stiffness of the neck for one day.

Physical Examination.—He was well nourished and decidedly apathetic. He was irritable if disturbed; recognized his parents' voices, and called them by name. His expression was drowsy most of the time. The way in which he reached out his hands suggested a disturbance of vision. There was internal strabismus of the right eye and nystagmus of both eyes. The neck was slightly rigid. The reflexes were normal. No Kernig nor Babinski reflex was elicited. The eye grounds showed papillary congestion. The line of the disk was indistinct, and the vessels were somewhat tortuous. The head measured 53 cm. (21 inches); the chest, 55 cm. (21¾ inches). The height was 97 cm. (38¼ inches). The abdomen measured 48 cm. (19 inches).

Course in Hospital.—July 8, the apathy had disappeared to a great extent. The child was bright, talkative, observant, but still irritable. Impairment of vision was shown by his reaching out when he walked and by his running into objects. Knee-jerks could not be obtained on either side. There was paralysis of the external rectus of the left eye.

July 16, he had to be fed by gavage. He was drowsy and resented being disturbed. The Kernig sign was positive; Macewen's sign was present. The reflexes were still absent.

July 25, he took food better. Vomiting occurred once a day. He was still drowsy and spoke only when aroused. Speech was inarticulate.

July 29, drowsiness was slowly increasing. He vomited on an average of once a day. Macewen's sign was more pronounced. Respiration was slow, 13 per minute and irregular; the pulse was 120 and somewhat irregular.

August 7, the only significant change since the last note was that stupor was so great that he could not be roused.

August 14, he was in a comatose state all the time. He never spoke nor did he comprehend what was said to him.

August 22, he was fed by gavage. Paralysis of the left side of face had developed in the last three or four days; but he could close the left eye perfectly.

August 31, the circumference of the head was 54.5 cm., as compared with 53 cm. on admission. Dropped wrists had developed during the last few days,

more marked on the right side. He retained an adequate amount of food by gavage, and was gaining in weight.

September 3, the condition showed a decided change for the worse. Breathing was noisy; there was a rattle in the throat and large, moist râles in the chest. Drooping of both lids had been present for some time; but today there was a pronounced drooping of the right upper lid. Respiration was regular in depth and rhythm, 25 per minute. He did not move the extremities.

September 5, respiration was slow, deep and regular. No convulsions occurred. Temperature was 104.5 F. It began to increase two days previously. He died this morning.

Necropsy Findings.—Sept. 4, 1915: The body was that of a moderately emaciated white boy. The head seemed too large for the body. There were no skin lesions. The scalp was normal. The sagittal and lambdoid sutures were open, leaving a line of membrane 2.5 mm. between the bones. The posterior

TABLE 4.—LABORATORY FINDINGS IN CASE 2

Blood Examination	Leukocytes	Polymorphonuclears, per Cent.	Lymphocytes, per Cent.	Basophils, per Cent.
7/ 7/15	17,000	49	51	...
7/ 8/15	18,000	60	40	...
7/ 9/15	26,000	67	32	1
7/10/15	14,000	81	19	...
7/11/15	13,000	76	24	...
7/12/15	12,000	79	20	1
	14,000	65	35	...

Spinal Fluid	7/7/15	7/8/15	7/13/15	7/20/15	7/23/15	7/29/15
Amount	27 c.c.	7 c.c.	20 c.c.	15 c.c.	20 c.c.	15 c.c.
Appearance	Clear	Clear	Clear	Clear	Clear	Clear
Pressure	Increased	No increase	No increase	Increased	No increase	Increased
Cells	—	96 (polymorphonuclears, 19%; lymphocytes, 81%)	7 (polymorphonuclears, 0; lymphocytes, 100%)	10 (lymphocytes, 100%)	3 (lymphocytes, 100%)	5
Globulin	—	—	+	+	0	0
Fehling's test	—	—	—	—	+	—

Wassermann test	July 15	July 20	July 22
Blood	0	—	0
Spinal fluid	0	0	—

fontanel measured 0.5 by 0.5 cm. The dura and pia were smooth and glistening, their vessels moderatelyy congested, and without evidence of inflammatory exudate or tubercles. The contour of the cerebral hemispheres was normal. Their anteroposterior diameter was 17 cm.

When the brain was removed 250 c.c. of fluid ran out, at first clear, later blood-stained. The cerebellum was large and asymmetrical. It contained a firm, round neoplasm occupying part of the left hemisphere and all of the inferior vermiform process. The right cerebellar hemisphere was indented to receive the right border of the tumor, which contained a cyst, 1.5 cm. long anteroposteriorly. It was covered with a shell of cerebellar substance, 2.4 cm. thick, and could be shelled from its bed except on its superior surface where it infiltrated the cerebellum.

On section, the growth was pinkish gray, firm and vascular, with one necrotic zone, 0.5 cm. in diameter. This area of necrosis was yellow and had a small cavity in its center, evidently the result of a small hemorrhage. The medulla was distorted because the growth pushed it toward the right. Consequently, the left half of the medulla was narrower and thinner than the right

half. The pons was less changed externally. The fourteenth ventricle was large, with its floor distorted from pressure of the tumor in the medulla. The aqueduct of Sylvius and the lateral ventricles were dilated. The cerebral substance was firm and only slightly thinner than normal. The optic tracts appeared to be atrophied.

Anatomic Diagnosis: Subpial neoplasm of the cerebellum, involving the left hemisphere and the vermis; hydrocephalus; compression of the right cerebellar hemisphere, pons and medulla.

Microscopic Examination.—The characteristic cell in the tumor had a round body with demonstrable processes. Very few spindle shaped cells were seen. Blood vessels were numerous in the network between the cells, and small hemorrhages were present. Through the soft, yellow part of the tumor, the section showed a blood clot surrounded by a zone of necrosis.

Diagnosis: Glioma (astrocytoma) of cerebellum.

Localization of the Tumor: Subpial neoplasm of the cerebellum, involving the left hemisphere and the vermis; compression of the right cerebellar hemisphere, pons and medulla; hydrocephalus.

CASE 3.—F. D., boy, aged 17 months, was admitted to the Babies' Hospital, Dec. 18, 1916, because of paralysis of the right arm and leg. This condition was noticed about one week before. The parents were healthy; and there were two other healthy children. Birth had been normal. The baby was breast fed for four months and after that he was given milk formulas. He did fairly well, gained slowly, and weighed 16 pounds at 14 months of age. His development was that of a normal child. At 11 months he spoke single words. About one week previously, it was first noticed that he held his bottle with his left hand instead of with both hands. At the same time he did not move his right leg. With the appearance of the paralysis there was apparently no fever. For about one week he had been more drowsy and had slept more than usual. He had had a discharge from the left ear for about two months and from his right ear for about one week. There had been no convulsions, and no symptoms of disturbed digestion.

Physical Examination.—The baby was poorly nourished but did not look acutely ill. The edge of the liver was felt 2 cm. below the costal margin. The edge of the spleen was felt 2 cm. below the costal margin. There was no other variation from normal in the physical examination except in the nervous system. The head was not retracted. There was a slight stiffness of the neck on flexion of the head. The fontanel was closed. The face was drawn to the left. The eyes showed vertical and rotary nystagmus. The right eye was held partly open. Paralysis of the right arm was apparently complete. The legs were held rigid in extention. The left could be moved better than the right. At times the legs were crossed. He held his breath when he cried. The knee-jerks were active; the left more than the right. Patellar clonus was present on the right side. Ankle clonus was occasionally present on the left side. The Achilles reflex was active on the left side. The jaw reflex was hyperactive. Chvostek's sign was active. There was no carpopedal spasm. There was a slight Brudzinski sign.

Course in Hospital.—Dec. 23, 1916: The child was bright. He moved his head and tried to talk. Variability of physical signs was noticeable.

December 28, power in the right arm and leg had slightly returned. Paralysis of the right side of the face was sometimes pronounced; at times hardly noticeable. The child seemed much improved since admission.

Jan. 1, 1917, the weakness of the right side of the face and of the right arm and leg showed little change. At times it seemed less.

January 14, nutrition was slowly improving. There was no change in the nervous symptoms.

January 31, the most noticeable symptom for the previous two weeks had been irritability. This was particularly pronounced when the child was handled.

The condition was slowly becoming worse. He took his feedings fairly well. There was no special change in the weakness of the right arm and leg. At times it semed to be less and again the condition showed no change.

February 12, the child appeared better and brighter. The appetite was fairly good. Weakness of the right side was not so evident.

February 14, he had seemed better the preceding two days. He had gained considerably in weight. The weakness on the right side was not so evident. The appetite was improving. He was discharged to return for observation.

Discharge diagnosis was: marasmus, improved; infant feeding, improved; tetany improved.

Second Admission.—The baby was admitted to the hospital for the second time Oct. 29, 1917, when he was 2 years and 3 months old, because of a large head, a condition which was first noticed three months previously. The bowels had always been constipated. They moved once in three days and then only with castor oil. The child had to be forced to eat, and had taken only liquid food for several months.

Physical Examination.—He was poorly nourished, and the head was enormous. The baby lay in a position of opisthotonos and left pleurothotonos. The legs were rigid, and the legs and feet were extended. He was startled only by very loud noises. He was in a semicomatose state, sleeping most of the time. He did not sit up. He took no notice of his surroundings; he did not recognize his parents. He did not follow light, and apparently did not see. These symptoms had evidently been present for some time. The pupils reacted sluggishly. There was external strabismus in the right eye, and nystagmus of both eyes. The fundi showed double optic atrophy. The neck was rigid; flexion was almost impossible. Spasticity of all four extremities was noted, more pronounced on the right side. The fingers were flexed over adducted thumbs. The legs and feet were extended. There was wasting of the extremities. The palm muscles of the right hand and especially of the right thenar eminence were more atrophic than the left. The supinator reflex was exaggerated on both side. The triceps, biceps and knee reflexes were difficult to obtain on account of rigidity. The Achilles reflex was present and not exaggerated. The abdominal, epiglottic and cremasteric reflexes were not obtained. Ankle clonus was not obtained. The baby cried when pricked with a pin but did not attempt to draw its foot away. The head measured 55 cm. (21⅝ inches); the chest, 42 cm. (16⅝ inches). The height was 80 cm. (29¼ inches).

Provisional Diagnosis: Hydrocephalus, spastic quadriplegia, optic atrophy, idiocy, marasmus.

Course in Hospital.—October 30: The eye grounds were examined by Dr. Thomson. There was definite optic atrophy, more marked in the left eye. The atrophy was probably primary and of about one year's duration.

October 31, examination of the nervous system by Dr. Hunt revealed: hydrocephalus, probably secondary to some acute inflammatory process, as meningococcus infection, meningo-encephalitis or ependymitis causing a blocking of the aqueduct and of the foramina of Luschka.

November 5, cerebrospinal fluid leaked from the ventricular tap made October 31. The head was 54 cm. in circumference.

November 14, the head was 55.5 cm. in circumference. One cubic centimeter of phenolphthalein was injected into the right lateral ventricle. At lumbar puncture, twenty minutes later, 25 c.c. of clear spinal fluid was withdrawn. A faint trace of phenolphthalein appeared in Tube 2, which became definite in Tube 3. Twelve hours after injection of phenolphthalein it was still present in the spinal fluid.

November 20, lumbar puncture was performed, 60 c.c. of cerebrospinal fluid being withdrawn. No phenolphthalein was present. The head measured 57 cm. before puncture; 56.5 cm. after puncture. The child was steadily growing worse.

December 16, the circumference of head was 58 cm. He was semicomatose.

December 25, he was semicomatose; opisthotonos was marked; there was pleurothotonos to the left side. The sutures were wide open. The pupils were dilated, the right larger than the left. There was no reaction to light. Almost every forty-five seconds there were noted a rapid oscillation and lateral nystagmus, usually to the right. The neck was rigid and retracted. The heart was regular in rhythm. The fingers were reflexed over the thumbs and rigid. The arms were held rigid; more so on the right side. There was hyperextension at the right elbow joint; the forearm was flexed only with considerable force. Both upper arms were held close to the side, drawn in by contraction of the pectoral muscles. This was more pronounced on the left side. There was marked scissors deformity caused by adductor spasm between the knee and hip joints. It was impossible to flex the right knee joint. The toes of the right foot were in plantar flexion; the left in dorsal flexion. The muscles of the lower extremities were much wasted. The only movement in the lower extremities was at the hip, where there was a slight flexion. None of the deep or superficial reflexes were obtained. There was a growth of fine hair over the cheeks, abdominal wall (extending to the midclavicular line), thighs and both legs. The eyelashes measured at least 1 cm.

Jan. 6, 1918, the baby was growing weaker daily. For three days he had seemed moribund. Three large decubital ulcers had appeared over the occiput

TABLE 5.—Laboratory Findings in Case 3

Spinal Fluid	12/19/16	12/22/16	10/29/17	10/30/17	11/2/17
Amount	5 c.c.	5 c.c	15 c.c.	25 c.c.	20 c.c.
Appearance	Clear	Clear	Clear	Clear	Clear
Pressure	Increased	No increase	No increase	Slight	Slight
Cells	5	Few scattered red cells	9	21 (lymphocytes, 100%)	15
Globulin	+	Faint	—	—	—
Dextrose	+	+	—	—	—
Noguchi test	—	—	+	+	+
Fehling's test	—	—	0	0	0
Remarks	—	—	—	Right ventricle	Left ventricle

Wassermann test, blood and spinal fluid	Negative
Pirquet test	Negative
Urine	Negative
Eye grounds	Negative

exposing the bone. The lower teeth were bent back so that they lay almost parallel with the floor of the mouth.

January 15, he had grown progressively weaker since the last note. He had appeared moribund for days. He rarely cried when disturbed, and died quietly this morning.

Necropsy Findings.—Jan. 13, 1919: The body was that of a markedly emaciated, white boy with a large hydrocephalic head. All sutures were wide open. There were three large decubital ulcers over the occiput, exposing the skull; there was one smaller decubital ulcer over the sacrum.

After opening the cranium, 1,500 c.c. of fluid was withdrawn from the ventricles. The brain immediately collapsed. The surface of the brain was covered with dilated and congested vessels; but there was no evidence of inflammation of the meninges. The cerebral cortex was only from 3.5 mm. to 5 mm. thick. The thinnest portion was just in front of the left fissure of Rolando. At the base of the left cerebral hemisphere there was a tumor 7 by 6 cm., which involved both optic thalami and both corpora striata. The left ganglions were much larger than the right. The tumor was sharply separated from the pons. In the floor of the left lateral ventricle the tumor measured 8 by 9 cm. The

right lateral ventricle was less dilated than the left, and its walls showed no bulging at any point. The aqueduct of Sylvius and the third ventricle were not dilated. The foramina of Monro were obliterated by direct pressure of the tumor. The choroid plexus in the floor of the lateral ventricles was much flattened. The cisterna magna was dilated to such an extent that it formed a cyst, 4 by 4 cm. Over the tumor the pia arachnoid was very thick and yellow. There were no signs of acute meningitis. The pons was asymmetrical because the neoplasm had pressed upon the anterior portion of its left half. The left cerebral peduncle was much compressed. The entire interpeduncular space was obliterated.

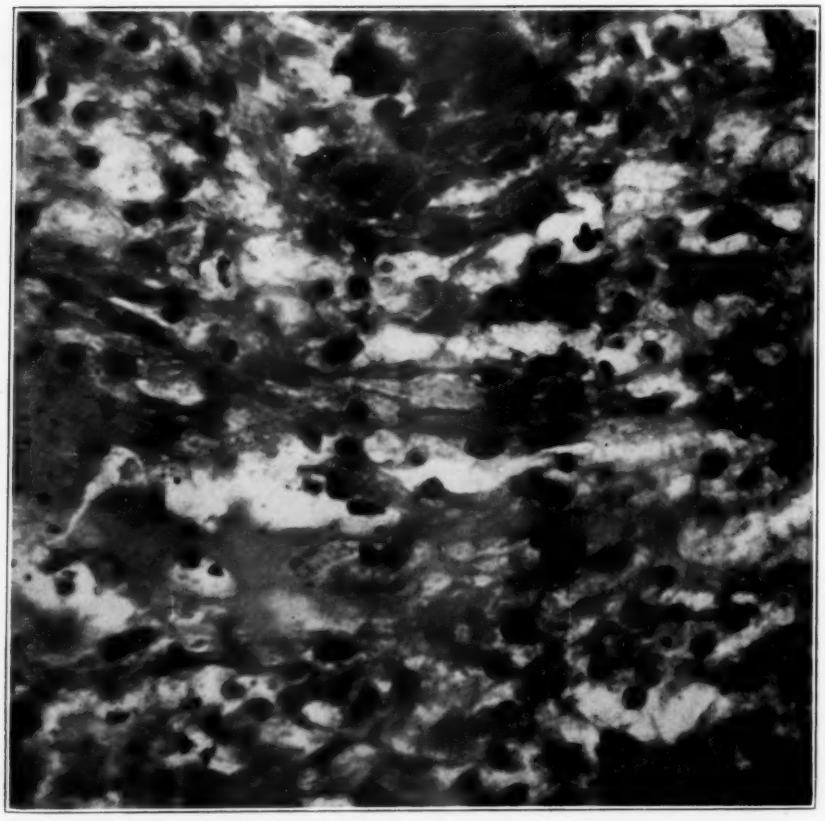

Fig. 1 (Case 3).—Glioma of the basal ganglions, marked edema; reduced from photomicrograph; × 250.

On section, the tumor was yellow, gelatinous in some portions, with areas of hemorrhage and softening. The posterior half was more firm in consistency.

The cerebellum was flattened from the weight of the enlarged cerebral hemispheres. The upper cord segment and the medulla were normal in outline.

Anatomic Diagnosis: Glioma of optic thalami and corpora striata (telencephalon and diencephalon); hydrocephalus; compression of cerebellum, pons and left cerebral peduncle.

Microscopic Examination of the Tumor.—There was marked edema, and some fairly large blood vessels contained thrombi. These were surrounded by

areas of necrosis in which all cell structure had been lost. The cell unit was star-shaped, with a small round body and nucleus. The processes united to form a network. Blood vessels were numerous and had very thin walls. No spindle cells were present. There were large spaces filled with serum.

Diagnosis: Glioma (astrocytoma) of basal ganglions (Fig. 1).

Localization of the Tumor: Glioma of optic thalami and corpora striata (telencephalon and diencephalon); compression of the cerebellum, pons, left cerebral peduncle and optic tract; hydrocephalus.

CASE 4.—R. D., boy, aged 16 months, was admitted to the Babies' Hospital, June 21, 1913, because of a large head. The increase in size was first noticed about four months previously. The parents were healthy. One other child had died during forceps delivery. The birth of this baby was normal. He had been breast fed. He sat alone at 10 months, and had just begun to walk and talk before this illness. He was always bright and playful. The head had begun to increase in size about four months before admission. There was no history of infection. He had never had convulsions.

Physical Examination.—The child was poorly developed, poorly nourished and apathetic. The expression of the face was dull and apathetic. Facial paralysis on the left side was complete. There was spasm of the muscles of the jaw. The mouth was opened with difficulty. The sagittal sutures were open, as was also the posterior fontanel. The anterior fontanel measured 11 by 7 cm. Expansion of the chest was less on the right side. This appar-

TABLE 6.—LABORATORY FINDINGS IN CASE 4

Spinal Fluid:	Amount	30 c.c.
	Appearance	Clear
	Pressure	Slightly increased
	Cells	5 per c.c.
	Globulin	+
	Film	None found
	Organisms	None found

ently was due to paralysis of the sternomastoid and scalenus muscles. The arms were held motionless, and both of them were rigid. The legs were both spastic. There was pronounced spasticity of the muscles about the foot and hip. The knee-jerks were both exaggerated, the left more than the right. The eye grounds were not examined because of a film which covered both. The child died six hours after admission. The head measured 56.5 cm. (22½ inches); the chest, 40 cm. (15¾ inches). The height was 75 cm. (29½ inches). The abdomen measured 34 cm. (13⅜ inches).

Necropsy Findings.—June 23, 1913: The body was that of a fairly well developed and well nourished boy.

The head measured 22½ inches. The dura mater was congested, and there were adhesions between the dura and the pia, more numerous over the right hemisphere. At the base the dura mater was smooth. The pia was congested everywhere, and over the interpeduncular space it was thickened and turbid. There was no acute inflammatory exudate at any point.

The brain was very large, 700 c.c. of fluid came from the ventricles. The cerebellum, pons and medulla weighed 290 gm.; the cerebrum weighed 1,142 gm. The lateral ventricles were much dilated, but the cerebral substance was not greatly thinned. It measured 3 cm. in depth. The gray matter was pinker than normal; the white matter was unchanged in color. The consistency of the cerebral substance was normal. There was no tumor nodule in the cerebrum. The choroid plexuses were congested.

The cerebellum was much enlarged and measured 13 cm. transversely and 5 cm. anteroposteriorly. On the surface of the right cerebellar hemisphere, the

pia mater appeared turbid, thickened and bluish. The two hemispheres were joined by a tumor mass, which obliterated the vallecula and extended into the right half of the cerebellum. On the upper surface of the cerebellum, the mass was also apparent, and its transverse diameter measured 4 cm. This mass was a round, deep red tumor, separated from the cerebellar substance by a compressed area of white matter limiting it as with a capsule over part of its circumference, but infiltrating the cerebellum over the rest of its extent. The tumor occupied the entire depth and length of the median line of the cerebellum. It was firm. Many blood vessels were apparent in its substance, but no hemorrhages had occurred. The tumor was more deeply red than was the cerebellum itself. The substance of the right cerebellar hemisphere measured only 1 cm. in thickness, while the left hemisphere was four times as thick. The widest part of the tumor measured 7 cm. The growth had extended into the right cerebellopontile peduncle, over an area 3 cm. in diameter and 2.5 in depth. Here the tumor was of the same color and consistency as the larger one. It was covered by a layer of white matter and distorted the medulla and the left peduncle. The medulla was pushed to the left, and the cranial nerves along its left border were pressed against the bone.

TABLE 7.—LABORATORY FINDINGS IN CASE 5

Spinal Fluid: Amount	15 c.c.
Appearance	Clear
Cells: polymorphonuclears	1
lymphocytes	12
Globulin	0
Sugar	0
Film	None formed
Wassermann test	Negative
Pus from right tonsil	No tubercle bacilli found
Pirquet test	Negative
Intradermal tuberculin test	Negative
Urine	No abnormal findings

The medulla contained no neoplasm. The growth seemed to be limited to the vermis, right cerebellar hemisphere and right middle peduncle.

Anatomic Diagnosis: Subpial neoplasm of the cerebellum, involving the vermis, right cerebellar hemisphere and right cerebellopontile peduncle; compression of medulla and left middle peduncle; hydrocephalus.

Diagnosis: Glioma (astrocytoma) of the cerebellopontile peduncle.

Localization of Tumor: Subpial neoplasm of the cerebellum, involving the vermis, right cerebellar hemisphere and right cerebellopontile peduncle; compression of medulla and left middle cerebellar peduncle; hydrocephalus.

CASE 5.—W. J., boy, aged 13 months, was admitted to the Babies' Hospital, Sept. 30, 1921, because of failure to gain in weight for about five months. The parents were healthy. There was one other child, who was well. Birth had been normal. The patient had been a vigorous child up to 8 months of age, that is, until five months before admission. At 8 months he was sitting up alone and would stand holding onto a chair. He had frequent attacks of bronchitis. At 8 months of age (five months previously), he began to vomit the morning feeding. This had been repeated every second day. After two or three weeks he vomited two or three times a day, and, with the onset of vomiting, he began to lose weight. The bowels became constipated at the beginning of the illness. He weighed 26 pounds at 8 months of age. No other symptoms except vomiting and failure to gain in weight were noticed up to

six weeks previous to admission, that is, when he was about 11½ months of age. At this time ptosis of the right eyelid and retraction of the mouth were noticed. The mental condition at 11½ months was bright.

Provisional Diagnosis: Feeding case, encephalitis.

Physical Examination.—The child was much emaciated. He lay flaccid in bed and paid no attention to his surroundings. Mucopurulent material escaped from the mouth and nostrils with each breath. The anterior fontanel was closed. The pupils were equal and reacted to light. There was ptosis of the right eyelid. Weakness of the entire left side of the face was noted. The mouth drooped to the left and was wide open on that side. From both nostrils mucopus was escaping. There was no rigidity of the neck, and no paralysis of the extremities. A good view of the soft palate was not obtained, but partial paralysis was probable because fluid given by mouth was returned through the nose. The abdominal reflexes were absent on the right side and present on the left side. The triceps reflexes were absent. Ankle clonus was not noted on the right; it was present on the left. There was no Kernig sign. Sensation was apparently undiminished.

Measurements: The height was 78.5 cm. (31 inches); the head measured 47 cm. (18½ inches); the chest 34.5 cm. (15½ inches); the abdomen 30.5 cm. (12 inches).

Diagnosis: Epidemic (lethargic) encephalitis; acute bronchitis.

Course in Hospital.—October 1, a more satisfactory examination of the pharynx revealed paralysis of the right side of the palate. Dr Johnson, who examined the child outside, stated that he saw pus escaping from behind the right tonsil.

October 4, neurologic examination by Dr. J. R. Hunt revealed that there was apparently a sympathetic ptosis of the right eye. There was slight rigidity of the neck and slight asymmetry of the facial innervation, on the right more than on the left. Otherwise, there were no objective symptoms referable to the nervous system. It is possible that the peritonsillar pressure was responsible for the sympathetic ptosis and mechanically caused asymmetry of the soft palate. (This observation was confirmed at necropsy.)

October 6, the eyes were examined by Dr. E. S. Thomson. The optic nerves showed no change; but the vessels, central artery and vein were somewhat dilated and rather active for general depression. The right third nerve showed some irritation in the pupillary and levator branches. The left facial nerve was partly paralyzed. There was nystagmus and probably a multiple intracranial lesion. The progressive downward course of this case led to the general belief that it was a case of brain tumor rather than encephalitis.

October 7, the child died.

Necropsy Findings.—Oct. 8, 1921: The body was that of an extremely emaciated, white male infant. The scalp and cranial vault were normal; the dura showed no lesion. Over the cortex, the pia was markedly edematous, and almost gelatinous in consistency. The vessels all contained easily movable thrombi. There was no evidence of cerebral hemorrhage, nor were sclerotic areas present. The frontal lobes appeared to be unusually short, especially on the upper surface. On removing the brain an increased amount of cerebrospinal fluid ran out. Over the inferior surface of the cerebrum the vessels of the pia were markedly less congested than over the cortex, and, in contrast, the inferior surface of the right cerebellar hemisphere appeared dark red. This was due to a subpial neoplasm, irregular in surface contour, and measuring 5 by 4 cm. in diameter. This growth occupied the anterior half of the right cerebellar hemisphere and encroached on the medulla and the vermiform, but not on the left cerebellar hemisphere (Fig. 2).

The medulla and the first cervical segment of the cord were pushed to the left, and the consistency of the medulla was very soft. The posterior border of the pons was also involved in the growth. There was no distinct line of demarcation between the neoplasm and the brain substance, and the growth could not be peeled out.

When transverse sections were made through the hemispheres after hardening, the lateral ventricles were found dilated to a moderate degree and equally.

The tumor occupied the anterior half of the right cerebellar hemisphere, and all of the vermiform process. It formed the roof of the fourth ventricle as well as its sides. The medulla was compressed from above downward and to the left. The cavity of the fourth ventricle was dilated; but it was largely

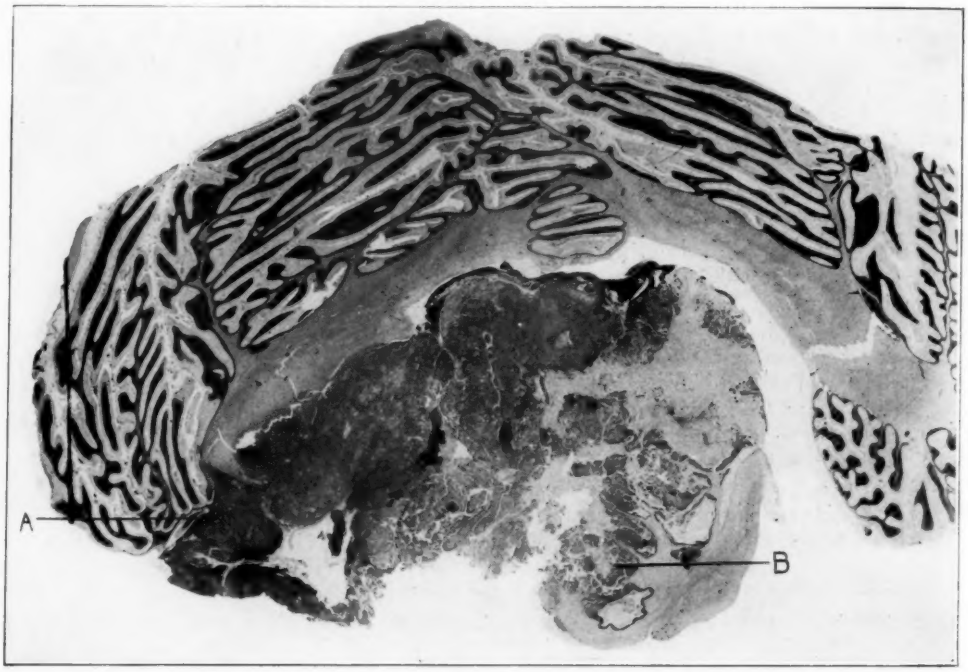

Fig. 2 (Case 5).—Glioma involving the right cerebellar hemisphere, vermis and medulla: *A*, glioma infiltrating the cerebellar substance; *B*, glioma infiltrating the medulla, which is pushed to the left.

filled by a cyst of irregular shape, which extended into the aqueduct of Sylvius above and into the substance of the cerebellar tumor behind (Dr. Hunt). This cyst caused the soft consistency of the medulla noted in the fresh specimen. The wall of the cyst was adherent to the floor of the fourth ventricle. The aqueduct of Sylvius was dilated (Fig. 3). The third ventricle and the foramina of Monro were also dilated.

Microscopic Examination.—The pia arachnoid was normal; its vessels contained blood. The nerve cells were in good condition, both in the anterior and in the posterior horns. In the posterior column there was a rarefied area about several blood vessels as though edema and slight loss of nerve elements had occurred.

The cells composing the new growth were round, with comparatively large nuclei. Many nuclei showed karyokinesis. Fusiform cells were not numerous, but processes could be demonstrated on the round cells. The blood vessels were very thin walled, small and numerous. The cerebellar substance just beyond the infiltrating neoplasm was edematous. In the aqueduct of Sylvius, a markedly edematous piece of the cyst wall was apparent. The substance of the pons was free from tumor growth.

Anatomic Diagnosis: Subpial neoplasm of the cerebellum, involving the right cerebellar hemisphere, vermis, medulla and pons; cyst of fourth ventricle; compression of the medulla and first cervical segment of the spinal cord.

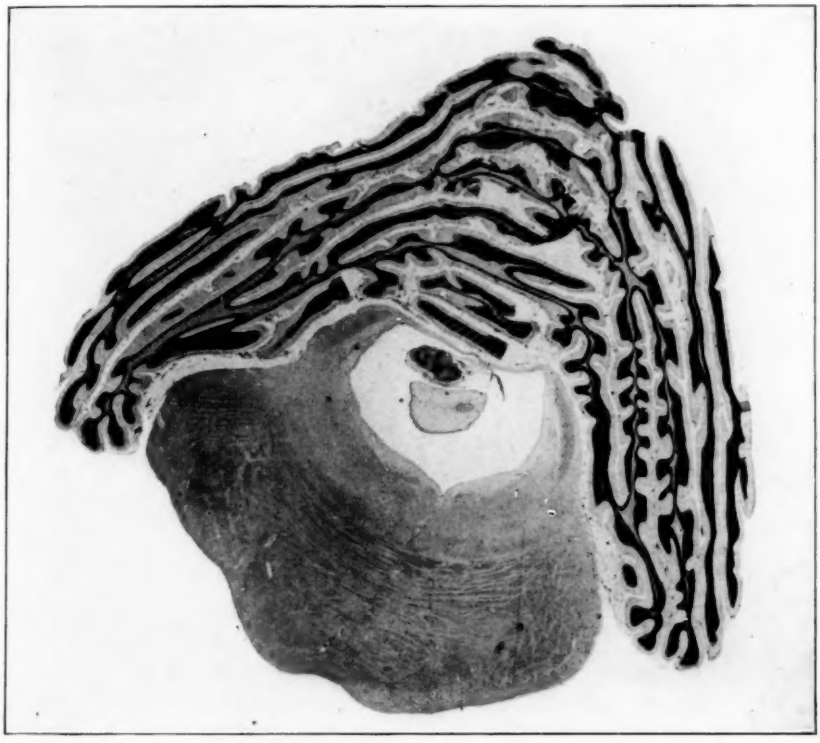

Fig. 3 (Case 5).—Dilated aqueduct of Sylvius showing wall of cyst of the fourth ventricle.

Microscopic Diagnosis: Glioma (astrocytoma) of the cerebellum and the medulla.

Localization of Tumor: Subpial neoplasm of the cerebellum, involving the right cerebellar hemisphere, vermis, medulla and pons; compression of the medulla and the first cervical segment of the spinal cord.

Case 6.—S. K., boy, aged 7 weeks, was admitted to the Babies' Hospital, Jan. 16, 1914, because of a "large head." An increase in size was first noticed at about 2 weeks of age. The child was a full term baby, and the birth was normal. At birth he weighed 6 pounds and 5 ounces. At 2 weeks of age it was noticed that his head was growing too large. At 2½ weeks of age the white of the eye began to show, and at about the same time it was noticed

that the veins of the scalp began to be prominent. Vomiting for the first time began at about 5 weeks of age; at times it was forcible.

Physical Examination.—The child gave the remarkable appearance of a small body suspended from a large head (Fig. 4). The head was enormous. It measured 51 cm. (20¼ inches). All the sutures were wide open. The lambdoid measured 30.5 cm. (12 inches), and the sagittal suture, 34 cm. (12½ inches).

Fig. 4 (Case 6).—Large head and emaciated body of 8 weeks old infant with glioma of the cerebrum.

The scalp was covered by a web of dilated veins (Fig. 5). The palpebral fissure was much widened, exposing the sclera above. Internal strabismus was present. Nystagmus of the rotary type came and went. The liver extended 3 cm. below the costal margin. The knee-jerks were present and active. The head measured 51 cm. (20¼ inches).

Provisional Diagnosis: Internal hydrocephalus.

Course in Hospital.—January 20, the head measured 51.5 cm.

January 23, the head measured 52 cm. The patient was steadily growing weaker. The scalp showed discoloration over the anterior portion, where there was especially pronounced bulging.

January 24, the scalp opened spontaneously in the region of discoloration, and fluid escaped. A hernia cerebri appeared through the rent, which was 9 cm. long.

January 26, the child died.

Necropsy Findings.—Jan. 26, 1914: The body was that of a poorly nourished male child. There were no skin lesions. The head was large and hydrocephalic, measuring 48.5 cm. in circumference. The veins over the scalp were distended. A large hernia cerebri protruded through a tear in the skin of the

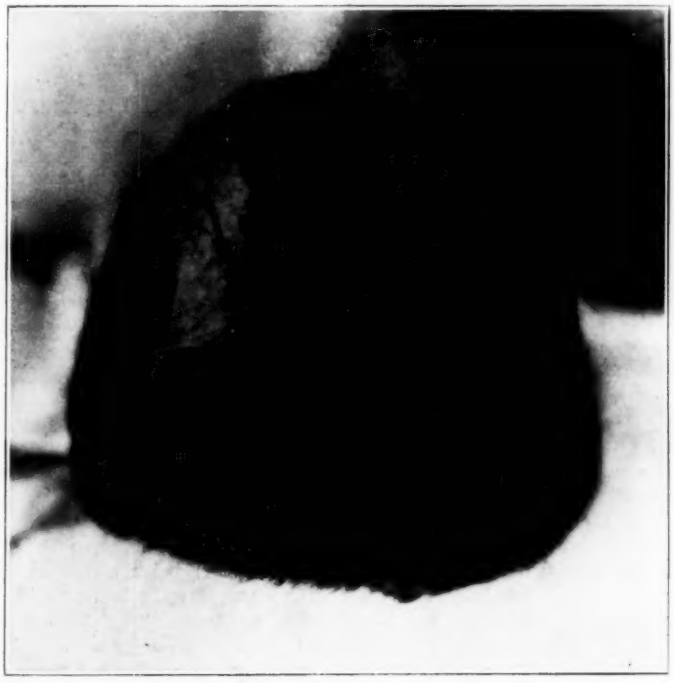

Fig. 5 (Case 6).—Network of dilated veins on the scalp of an infant with glioma of the cerebrum.

left frontal region. The prolapsed mass measured 8 cm. by 5 cm. in diameter. Blood-stained cerebrospinal fluid oozed from the protruding mass of cerebral substance. The dura mater showed many punctate hemorrhages, most numerous over the parietal bones.

The brain was asymmetrical, the left hemisphere being three times as large as the flattened right. The tentorium cerebri was not in the middle line, having been pushed over by the large left hemisphere. The basal fossae were distorted. The left anterior fossa was twice as large as the right, but in the middle and posterior fossae the difference was less pronounced.

The olfactory lobes were thin and flattened, and so was the whole optic commissure. The entire left hemisphere was filled with the new growth, which, on section, showed many recent hemorrhages, softened areas and yellow streaks of old hemorrhages.

A mass weighing 145 gm. broke off from the portion protruding anteriorly. The cortex on the left side covered the neoplasm like a thin shell only 1 cm. in thickness. The right hemisphere showed some flattening of its convolutions and dilation of its lateral ventricles.

The cerebellum was flattened to one-half its normal size. The medulla and pons were also flattened. The fourth ventricle was not dilated.

The left hemisphere measured 19.5 by 14 by 3 cm.; the right 16.5 by 8.5 by 7.5 cm.

Anatomic Diagnosis: Central neoplasm of the cerebrum; hernia cerebri; hydrocephalus; compression of the cerebellum, pons, medulla and optic tract.

Microscopic Examination.—The tumor was composed of round cells with a comparatively small body and a large nucleus, staining deeply. Many mitotic nuclei were present. The cells were very closely arranged, and processes or fibrils were numerous; they could be seen clearly in the edematous parts of the tumor.

There were many blood vessels with very thin walls. The cells were arranged around the vessels, but had no connection with the cells of the vessel walls. In some areas the cells were spindle shaped, but the majority everywhere were round. Areas of necrosis were apparent.

From the number, small size and close packing of the cells, the section gave the appearance of glioma sarcomatoides (Borst) or gliosarcoma. Its origin was probably in the substance of the left hemisphere. Sections through the

TABLE 8.—LABORATORY FINDINGS IN CASE 6

Spinal Fluid: January 19	Culture	Negative
January 21	Color	Yellow
	Pressure	Increased
	Cells	130
	Polymorphonuclears	63 per cent.
	Lymphocytes	37 per cent.
	Fehling's test	+
	Globulin	++
Blood Test: January 20	Wassermann test	Negative
January 18	Pirquet test	Negative

left lateral ventricle showed a portion of the choroid plexus in the form of cellular villi carrying small blood vessels and covered with epithelial cells.

Sections through the left cerebral cortex showed edema and a diminished number of nerve cells when compared with sections through the same area of the right cortex.

Localization of Tumor: Central neoplasm of the cerebrum; compression of the cerebellum, pons and medulla and optic tract; hydrocephalus; hernia cerebri.

CASE 7.—R. S., girl, aged 10 months, was admitted to the Babies' Hospital, Sept. 22, 1917, because of vomiting which began about three weeks before admission. The parents were healthy. There was one other child, who was healthy. The birth was normal. She had been breast fed to the present. Whooping cough occurred at 6 months of age. Vomiting began about three weeks previously, following a slight fall on the floor. Irritability began about seven days previously and was noticed when the child was handled. Drowsiness had been noted for four or five days. The eyes had looked "peculiar" for three weeks; no squint and no nystagmus were noticed. Constipation had been present for one week. There were no convulsions, no pain and no retraction of the head.

Physical Examination.—The child was well developed and well nourished but appeared acutely and chronically ill. She was very restless and constantly

made purposeless movements of her arms and legs or assumed a cataleptic position. Twitching of the hands and legs was noted at times. There was bulging of the fontanel (3 by 3.5 cm.). There was irregular strabismus, but usually, right external. No nystagmus was noticed. The eyes were fixed and glassy. There was no rigidity of the neck and no retraction. The extremities were rather spastic; there was no paralysis. The knee-jerks were exaggerated; the Babinski and Kernig signs were present.

Provisional Diagnosis: Tuberculous meningitis; brain tumor.

Course in Hospital.—September 26, since admission there had been but little change in the child's condition except that she was growing weaker. The ner-

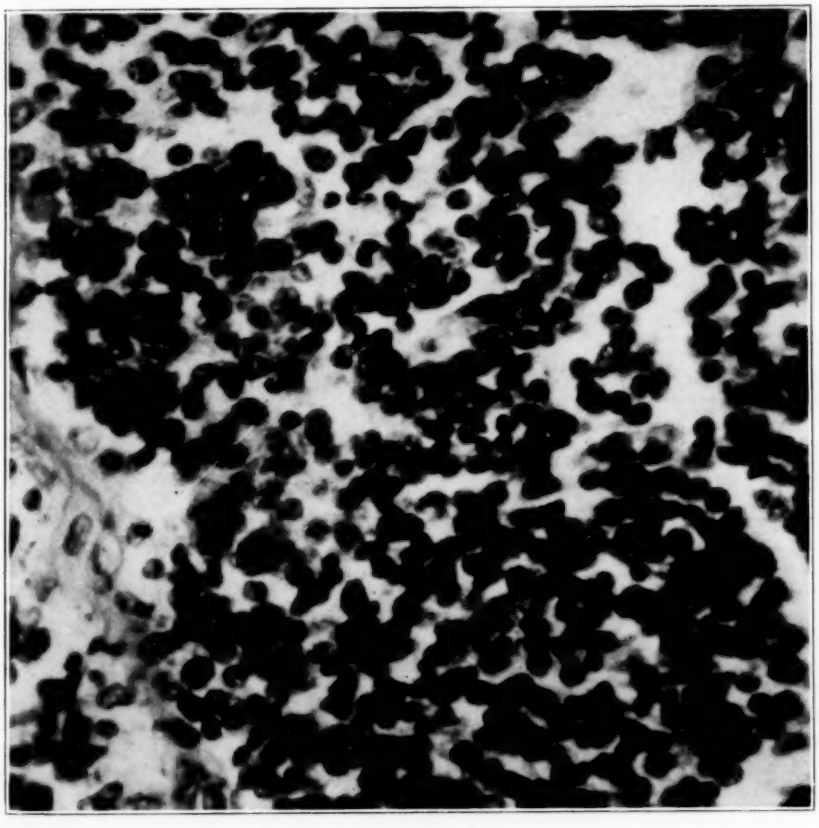

Fig. 6 (Case 6).—Glioma sarcomatoides of cerebrum in infant, 8 weeks old.

vous symptoms were the same as on admission. The patient constantly moved her hands and arms or assumed a cataleptic position. There was slight flattening of the left side of face.

September 28, the child died suddenly.

Necropsy Findings.—Sept. 28, 1917: The body was that of a well developed, well nourished white baby girl. The anterior fontanel admitted three fingers. There was moderate craniotabes, but no beading of the ribs and no skin lesions. The dura and the pia-arachnoid presented nothing abnormal. The cerebral hemispheres were normal in appearance, and no lesion was apparent over the brain cortex. At the base there was a neoplasm in the inferior

vermiform process of the cerebellum, flattening the medulla and about 1.5 cm. of the cervical cord and pushing the medulla and the pons to the right. The growth measured 4.5 by 3 by 3 cm. It occupied the entire length and breadth of the vermiform process, extended into the middle cerebellar peduncle and into the right cerebellar hemisphere to a distance of about 2 cm. Viewed from above, the tumor was more prominent on the right side of the cerebellum; looked at from below it showed more prominently on the left side, and had displaced the medulla, distorting the fourth ventricle. The growth was rather soft, and on section it was pink, with small hemorrhages and one softened area, 0.5 cm. in diameter. All the ventricles and the aqueduct of Sylvius were dilated moderately. The cerebral cortex was not thinned.

Anatomic Diagnosis: Subpial glioma of the cerebellum, involving the vermis, the right cerebellar hemisphere and the cerebellopontile peduncles; hydrocephalus; compression of medulla and upper segment of the cervical cord.

Microscopic Examination.—The tumor is a glioma (astrocytoma) with comparatively large blood vessels.

TABLE 9.—LABORATORY FINDINGS IN CASE 7

	Sept. 23, 1917	Sept. 26, 1917
Spinal Fluid:		
Amount	—	20 c.c.
Color	Clear	Clear
Pressure	Increased	—
Cells	24 (lymphocytes, 100%)	90 (polymorphonuclears, 9%; lymphocytes, 91%)
Globulin	0	0
Sugar	0	+
Blood Test:		
Wassermann test	Negative	
Pirquet test	Negative	
Blood Examination:		
Leukocytes	13,000	
Polymorphonuclears	33 per cent.	
Lymphocytes	67 per cent.	
Eye Grounds:		
Blurring of mesial side of both disks, more marked on right side		

Localization of Tumor: Subpial glioma of the cerebellum, involving the vermis, the right cerebellar hemisphere and the cerebellopontile peduncles; hydrocephalus; compression of the medulla and upper segment of the cervical cord.

SUMMARY

1. In seven cases of tumor of the brain in children between the ages of 2 weeks and 3 years, the average age was 15 months.

2. All the tumors were gliomatous in type.

3. Two were supratentorial and five were infratentorial.

4. Of the supratentorial tumors, one occupied the left cerebral hemisphere and was congenital in origin. The other occupied the basal ganglions.

5. In the five infratentorial tumors the vermis of the cerebellum was involved. The growth involved the right cerebellar hemisphere in four and the left hemisphere in only one instance. The medulla and the pons were infiltrated in two cases, and the right cerebellopontile peduncle was involved in two instances. The upper cervical cord was compressed in three of the cases.

6. Hydrocephalus was present in each of the seven cases.

7. The most striking feature of the symptomatology is the variability in physical signs.

8. Convulsions were absent in all cases except one in which a convulsion occurred just before death.

9. Vomiting did not appear as a significant symptom in any of the cases.

10. The spinal fluids showed nothing that is distinctive. Xanthochromia was present in only one case in which there was a cerebral hernia.

THE CHARACTERISTICS OF THE CEREBROSPINAL FLUID IN POSTDIPHTHERIC PARALYSIS

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AND
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The characteristics of the spinal fluid in postdiphtheric paralysis has received scant attention in our own literature. There were no observations published in this country, as far as we could ascertain, until the report made previously by one of us (J. C. R.). Foreign workers, especially French clinicians, have published their investigations in a small number of cases. There has not been accumulated as yet, however, a sufficient amount of information on the subject to establish conclusively the cytologic and chemical alteration, if any, which may be encountered.

An exact knowledge of the condition of the spinal fluid in postdiphtheric paralysis is of some importance for two reasons: first, to determine the presence or absence of a reaction on the part of the meninges to the toxins of the diphtheria bacillus, and second, to assist in the differential diagnosis of this condition from certain other diseases which may be accompanied or followed by paralytic symptoms.

The disease clinically which is probably most likely to be mistaken for postdiphtheric paralysis is acute poliomyelitis. The difficulties of differentiating the two may be so great, under certain conditions, as when the history of initial angina is lacking or overlooked, that a positive diagnosis may only be assured by the course of the paralytic symptoms, and in fatal cases, in exceptional instances, by the examination of microscopic sections of the central and peripheral nervous system at necropsy. Yet an examination of the spinal fluids shows different characteristics in the two maladies.

There are other conditions with which diphtheric multiple neuritis is at times confused clinically. Briefly, these are capillary bronchitis, lobar pneumonia, laryngeal diphtheria, tabes dorsalis, epidemic encephalitis and the multiple neuritis following other infectious diseases, such as scarlet fever and measles. The details of the differential diagnosis of the disease will not be spoken of in this publication, as we are concerned primarily with the spinal fluid findings.

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* From the Kingston Avenue Hospital, Bureau of Hospitals, Department of Health, New York, Dr. R. J. Wilson, Director, and Dr. W. T. Cannon, Physician in Charge.

Certain previous reports have been made on this subject. De Massary,[1] Marfan,[2] Dufour,[1] Comby [1] and Netter [3] have failed in their cases to find any evidence of a meningeal reaction, as shown by an increased albumin content or lymphocytosis of the spinal fluid. On the other hand certain investigators have published cases in which they found a distinct lymphocytosis, with usually also an associated augmentation of albumin. Single cases in which such changes were observed are reported by Rohmfeld,[3] Chauffard and Le Conte,[3] Ravaut and Krolinetsky,[4] and Hallez and Lortat-Jacob.[5] De Lavergne [6] and others have noted instances in which there was a dissociation between the albumin which was augmented and the cells which were normal. The series of six cases with ten specimens of spinal fluid previously reported [7] by one of us (J. C. R.) showed alteration in only one instance by a 3 + albumin and a 2 + globulin reduction.

The present series comprised a total of sixteen patients and twenty-eight specimens of spinal fluid which were examined at intervals after the onset of the angina, varying from the sixteenth day to the thirteenth week and from the second day after paralysis had supervened to the eleventh week thereafter. Divided into groups according to the week of the paralysis on which the puncture was performed, these specimens of spinal fluid may be classified thus: first week, eight; second week, five; third week, five; fourth week, four; fifth week, two; sixth week, one; seventh week, one; eighth week, one; eleventh week, one.

The initial angina had been, in most instances, a moderately or very severe type with membrane involving the tonsils, uvula, pillars of the fauces, often also the soft palate, nasopharynx, nose and larynx. The diphtheria bacillus was usually associated with other microorganisms representing thus the polymicrobian, septic or mixed infectious form of the disease, with its characteristic heavy, thick, dark-

1. Discussion in Bull. et mém. Soc. méd. d. hôp. de Paris **45**:1097 (July 15) 1921, on Merklen, P., Weiss, M., and de Gennes, L.: Ibid. **45**:990 (July 1) 1921.

2. Marfan, A. B.: Leçons cliniques sur la diphthérie et quelques maladies des premières voies, Paris, 1905, p. 216.

3. Discussion on Chauffard and Le Conte; Paralysies nucléaires multiples d'origine diphtérique avec réaction meningés, Bull. et mém. Soc. méd. d. hôp. de Paris **39**:997 (Nov. 12) 1915.

4. Ravaut, P., and Krolinetsky, G.: Paralysie diphtérique généralisée avec réaction méningée Bull. et mém. Soc. méd. d. hôp. de Paris **40**:913 (June 9) 1916.

5. Hallez, G. L., and Lortat-Jacob: Le liquide céphalorachidien dans les paralysies diphtériques, Bull. et mém Soc. méd. d. hôp. de Paris **41**:1259 (July 6) 1917.

6. De Lavergne, M.: De l'altération du liquide céphalorachidien dans les paralysies diphtériques du voile du palais et à type de polyneurite, Bull. et mém. Soc. méd. d. hôp. de Paris **44**:1246 (Oct. 22) 1920.

7. Regan, J. C.: Postdiphtheritic Paralysis and the Spinal Fluid Findings, Arch. Pediat. **35**:641 (Nov.) 1918.

Summary of Cases with Spinal Fluid Findings

Age; Case No.; Date of Admission	Type of Diphtheria	Day of Disease Antitoxin Was First Given	Amount of Antitoxin		Day of Disease Paralysis Supervened	Distribution of Completely Developed Paralysis	Day of Disease Puncture Performed	Colloidal Gold Reaction	Cell Count per C. Mm.	Globulin	Fehling's Reaction	Other Complications	Outcome
			Before Admission in 1,000 Units	After Admission in 1,000 Units									
3 yrs. 814 3/15/22	Pharyngeal, nasal and sepsis	14th	..	40	19th 27th	Early: palate, larynx, cardiac arrhythmia. Later weakness lower extremities and back	29th	1 2 2 2 2 0 0 000	7	—	3+	Myocarditis nephritis, heart block	Died 4/10
3½ yrs. 1970 9/26/20	Pharyngeal, nasal	3d	..	30	16th 35th	Early: palate, cardiac arrhythmia. Later: upper and lower extremities, pharynx, strabismus	44th	1 1 2 2 3 3 3 200	3	1+	3+	Nephritis	Recovered
4 yrs. 584 2/25/22	Pharyngeal, nasal and sepsis	4th	10	35	14th 37th	Early: palate. Later: upper and lower extremities, back, neck, pharynx, diaphragm (weak)	16th 22d 37th	1 1 1 1½1½1½0 000 1 1 1 1 0 0 0 000 1 1 2 2 2 1 0 000	5 2 0	— — —	3+ 3+ 3+	.....	Died 4/1/22
1½ yrs. 697 3/6/22	Not observed; ill 5 weeks on admission	..	..	..	Approx. 3d week	Palate, pharynx, partial upper and lower extremities, strabismus, left facial, diaphragm (partial), atelectasis lower lobe both lungs	4th wk. 6th wk. 8th wk. 9th wk. 11th wk.	1 1 1½2 2 0 0 000 1 1 1½2 2 1 0 000 2 2 2 3 3 2 0 000 1½2 1 1 1½0 0 000 0 0 0 0 0 0 0 000	2 10 7 2 0	2+ 1+ — — —	3+ 3+ 3+ 3+ 3+	Myocarditis	Recovered
5 yrs. 183 2/25/22	Pharyngeal, nasal and sepsis	4th	10	25	12th 16th 27th	Early: cardiac arrhythmia, palate and left lower extremity. Later: pharnyx, larynx, back, neck, bulbar	20th 28th 35th	1 1 1 1½1½1½0 000 1 1 2 2 2 1 0 000	2 2 5	— 1+ —	3+ 3+ 3+	Myocarditis, nephritis	Recovered
5 yrs. 1811 9 16 '21	Not observed; ill 5 weeks on admission	1st wk.	unknown	..	2d wk. 4th wk.	Early: palate. Later, lower extremities, larynx, weakness neck and back	5th wk. 8th wk. 13th wk.	0½0½1 2½2½2 0½000 5 0 0 0 1½1 0 000 0 0 0 0 0 0 0 000	6 7 2	1+ 1+ —	3+ 3+ 3+	.....	Recovered

4 yrs. 823 3/16/22	Pharyngeal, laryngeal	3d	..	30	17th	Cardiac arrhythmia, slight pharyngeal	26th	0 0 0 0 0 0 0 000	5	—	3+	Intubation, myocarditis	Recovered
4 yrs. 1851 9/28/22	Pharyngeal, nasal and sepsis	2d	15	20	9th	Early: palate. Later: pharynx, strabismus, lower extremities, back, cardiac arrhythmia	35th 50th	1 1 1 1 1½0 0 000 1 1 1 1 1 0 0 000	10 5	± ±	3+ 3+	.....	Recovered
4 yrs. 861 3/20/22	Pharyngeal, nasal and laryngeal	3d	20	20	27th 32d	Early: palate, cardiac arrhythmia. Later: pharynx, larynx, bilateral strabismus, right ptosis, back and lower extremities	33d	2 2 2 3 3 2 2 11	2	—	3+	Myocarditis, intubation	Recovered
4 yrs. 860 3/20/22	Pharyngeal, laryngeal and sepsis	3d	15	30	13th 24th	Early: pharynx, palate, cardiac arrhythmia. Later: larynx, diaphragm, abdomen, strabismus	34th	1½2 3 3 2 ½0 000	2	±	3+	Myocarditis	Recovered
7 mos. 1657 6/7/22	Not observed	14th	10	..	11th 21st	Early: palate. Later: strabismus (right), pharynx, larynx	22d	2 2 2 1 1 0 0 000	7	—	3+	Broncho-pneumonia, intubation	Died 6/10
3 yrs. 1289 5/23/22	Pharyngeal ?, ill 3 weeks on admission	..	..	..	7th	Early: palate. Later: neck, back, bilateral strabismus, diaphragm	22d 25th	1 1 2 2 1 0 0 000 1 2 2½2 1½0 0 000	2 0	— —	3+ 3+	Broncho-pneumonia, myocarditis	Died 5/25
3 yrs. 823 3/6/22	Pharyngeal, laryngeal	6th	15	30	12th	Early: palate and pharynx	12th	2 2 3 ½ ½0 0 000	5	—	3+	Br.pneu., myocarditis, aph. stom., intubation	Recovered
7 yrs. 2253 12/21/22	Pharyngeal, nasal and sepsis	5th	..	40	26th	Early: palate. Later: left facial, cardiac arrhythmia	29th	1 1 1 1 0 0 0 000	5	—	3+	Myocarditis	Recovered
4½ yrs. 856 3/19/22	Pharyngeal, nasal and sepsis	2d	10	20	17th	Early: cardiac arrhythmia. Later: double internal strabismus	22d	1 1½2 1 0 0 0 000	0	—	3+	Myocarditis	Recovered
4 yrs. 1479 5/17/22	Nasal (child ill 1 month with slight aphonia, previous to which for an indefinite period there was a nasal discharge	..	..	..	unknown	Early: larynx. Later: right facial, palate, pharynx, weakness upper extremities, left intercostals and diaphragm	5/20 5/26	2 2 2 1 0 0 0 000 2 1 1 1 0 0 0 000	2 2	— —	3+ 3+	Otitis media, measles, pneumonia	Recovered

colored membrane, serous nasal discharge, cervical adenitis and periadenitis. One of the patients had a pure nasal diphtheria of indefinite duration which had never been recognized until the development of paralytic symptoms.

The paralysis was generalized in ten patients, was limited to an involvement of the pharynx in one, to the palate and pharynx in one, to the palate and left side of the face in one, to the palate, pharynx, larynx, extrinsic muscles of the eyes, diaphragm and abdominal wall in one, to the extrinsic muscles of the eyes, pharynx, larynx and palate in one, and to the extrinsic muscles of the eyes only in one. A cardiac arrhythmia was noted in a number of cases.

The punctures were performed with the aseptic technic of a major operation. The fluid was removed slowly with the child always in the prone position, and usually only from 5 to 10 c.c. was withdrawn.

The fluid was clear in all instances, of normal limpid watery transparency, and under normal or slight hypertension. A Bordet-Wassermann reaction was performed at least once on the spinal fluid of each patient, and the results were uniformly negative. The cell count was in every instance within normal limits, as will be seen in the accompanying table. The Fehling's reaction was normal in each fluid, namely a 3 + reduction, indicated by an immediate and heavy precipitate. In only two ways did the rachidian liquids show any abnormality. One was in the almost constant presence of a positive colloidal gold reaction in the syphilitic zone, and the other was in the occurrence in nine fluids from six patients of globulin varying in amount from a ± to a 2 + reaction.

No clear relationship could be shown between the type of the disease or its outcome and the presence of globulin in the spinal fluid. As shown by the table the globulin reaction was usually only mildly positive (1 +) and occurred in only about one third of the patients. The globulin seemed to diminish as convalescence was established and the paralysis disappeared.

The colloidal gold reduction was commonly confined to the first five or six dilutions (1 : 10 to 1 : 320); but in two instances it reached well into the meningitic zone (Cases 1970 and 861). In one instance (Case 823) there was no reaction, this patient having only a localized mild paralysis.

As the patients improved clinically the reaction seemed gradually to subside, and in two patients (Cases 697 and 1811), followed to the eleventh and thirteenth weeks of the disease, respectively, the curve had reached the normal level. This is the first report, we believe, of the results obtained by the employment of the colloidal gold reaction in postdiphtheric paralysis.

SUMMARY

To determine whether a meningeal reaction occurs in the spinal fluid in postdiphtheric paralysis, and to assist in establishing the cytologic and chemical formula in that disease, which is of importance at times in differential diagnosis, a study of the rachidian liquid was carried out. A series of twenty-eight specimens of spinal fluid from sixteen patients were examined at various intervals, from the second day to the eleventh week of the paralysis, twenty-two being in the first four weeks. Nearly two thirds of the patients had extensive generalized paralysis, and in five death supervened. These paralyses followed usually a moderately or very severe initial angina commonly of a polymicrobian or septic form, with extensive membrane formation and frequently accompanied by myocarditis.

CONCLUSIONS

From the results of the examination of the spinal fluid in a previous series and in the present one, we feel that the following tentative conclusions may be drawn:

1. The cerebrospinal fluid in postdiphtheric paralysis is a clear limpid liquid, flowing usually under normal or slight hypertension.

2. The Bordet-Wassermann reaction of the spinal fluid was uniformly negative in each case.

3. The cell count was always within normal limits, less than 10 cells per c.mm., and the cells found were small lymphocytes.

4. The globulin was increased in a minor proportion of the patients, less than one third. The increase was slight, occasionally moderate, never marked.

5. There existed, therefore, in certain cases (less than one third) a dissociation between the cytologic and chemical findings.

6. The colloidal gold reaction was the most constantly positive pathologic reaction encountered in the fluid of this disease. The reduction usually occurred in the syphilitic zone, occasionally extending into the higher dilutions. The reaction seemed gradually to subside, reaching normal as convalescence was established and paralysis disappeared.

TRANSFUSION THROUGH THE UMBILICAL VEIN IN HEMORRHAGE OF THE NEW-BORN

REPORT OF A CASE

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The use of human blood as a therapeutic agent in melena or hemorrhagic disease of the new-born has been one of the gratifying advances in medicine during the last decade. Human blood has acted as a specific in this condition.

HISTORY

The first transfusion of blood for hemorrhagic disease of the new-born was performed in New York City by Dr. Alexis Carrel in 1908.[1] The method was direct transfusion from the left radial artery to the right popliteal vein. The baby recovered. In 1909 Dr. Crile introduced the cuff and cannula method. In 1910 the Elsberg cannula was introduced, and, during the same year, Vincent of Boston introduced the method employing the paraffin coated glass tubes.

In 1913 Lindemann aroused considerable interest in transfusion by introducing the syringe method, which simplified the procedure and, at the same time, gave a method by means of which the quantity given could be accurately measured.

In 1915 Lewisohn [2] reported two cases in which transfusion was performed by the citrate method. Since then many modifications of these methods have been reported with good results in all. For the sake of brevity, they can be divided into two general groups, namely, direct and indirect. In one treated blood is used and in the other untreated blood.

In 1908 the first case of hemorrhagic disease of the new-born was treated by subcutaneous injection of whole blood by Schloss. Between 1908 and 1911, seven such cases were treated by him with one death.[3] In 1910 Welch [4] reported twelve cases treated by transfusion. Since then a large number have been so treated with good results.

ROUTES

In infants the routes that have been used are the superficial veins of the arm, of the neck, of the scalp and the popliteal or femoral vein.

* Received for publication, Feb. 5, 1923.

1. Lambert: Med. Rec. **73**:883 (May) 1908.
2. Lewisohn, R.: Surg., Gynec. & Obst. **21**:37 (July) 1915.
3. Schloss, O. M., and Commiskey, L. J. J.: Spontaneous Hemorrhage in the New-Born, Am. J. Dis. Child. **1**:276 (April) 1911.
4. Welch: Am. J. M. Sc. **139**:800, 1910.

In September, 1915, Helmholz [5] was the first to bring to our attention the employment of the superior longitudinal sinus as a route for the aspiration of blood as well as for injections. In the same year, Howard [5] used the superior longitudinal sinus, injecting citrated blood. Since then this route has been used frequently on account of its accessibility in very young infants. In 1919 I used the umbilical vein in an infant 4 days old, giving 100 c.c. of whole blood by the syringe method, with satisfactory results.

ETIOLOGY

The etiology of this condition is not known. The following factors are thought to have some bearing:

1. Hypoplasia of the coagulating elements of the blood may be a factor. According to Schloss and Commiskey,[6] "the cause for persistent bleeding in these cases must be due to some defect in the normal mechanism of the blood clotting time." They report ten cases which showed a coagulation time varying from normal to indefinite times, showing that the bleeding is not always dependent upon hemorrhagic diathesis. Another interesting point here is that the injection of blood cures these patients immediately and they have no return of symptoms. Transfusions do not cure patients with hemophilia.

2. From 2 to 6 per cent. of these cases are syphilitic, according to Holt.

3. Infection seems to act as a predisposing factor.

4. From observation, we note that babies that have been more or less asphyxiated have a tendency to bleed.

5. Trauma, such as is frequently suffered in difficult deliveries, and the common methods of resuscitation may well be exciting causes.

Rodda [7] has called our attention to the fact that as many as 50 per cent. of the necropsies in cases of stillbirth or on infants that die a few days after birth reveal hemorrhages in different parts of the body, many of which were not recognized before death.

According to Brown and Swift,[8] these cases may be divided into three clinical types, namely: the umbilical, the seromucous, and the

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5. Helmholz, H. F.: The Longitudinal Sinus as the Place of Preference in Infancy for Intravenous Aspirations and Injections, Including Transfusion, Am. J. Dis. Child. **10**:194 (Sept.) 1915. Howard, W. S.: A Simple Method of Transfusion in Hemorrhage of the New-Born, J. A. M. A. **65**:1365 (Oct. 16) 1915.

6. Schloss, O. M., and Commiskey, L. J.: The Etiology and Treatment of the So-Called Hemorrhagic Disease of the New-Born, Am. J. Dis. Child. **3**:216 (April) 1912.

7. Rodda, F. C.: Coagulation Time of Blood in the New-Born, J. A. M. A. **75**:452 (Aug. 14) 1920.

8. Brown and Swift, cited by Lespinasse, V. D.: The Treatment of Hemorrhagic Disease of the New-Born by Direct Transfusion of Blood, J. A. M. A. **62**:1866 (June 13) 1914.

purpuric, with a mortality of 60, 50 and 22 per cent., respectively. This was before the use of serum and blood transfusion.

Rodda [7] has shown that these babies have a prolonged bleeding time as well as a delayed coagulation time. This may be increased up to fifteen or twenty minutes, and, in some cases, even longer.

OCCURRENCE

At the Boston Lying-In Hospital, Townsend [9] reported that bleeding in the new-born occurred in thirty-two infants in 5,000 births. Ritter found 190 cases among 13,000 births at the lying-in hospital at Prague. Epstein found that it occurred in 8 per cent. of the cases at the New York Foundling Hospital. From Rodda's recent article, we must conclude that these figures are based mainly on clinical diagnoses, and that the occurrence is a great deal more frequent than their figures would indicate. Rodda [7] states that "statistics from the New-Born Clinic, University of Minnesota, show that postmortem examinations reveal cerebral hemorrhage in more than 50 per cent. of all infants that die inter partum or during the first few days of life. These findings often were made following noninstrumental, or even easy, deliveries." It was also noted that these hemorrhages occurred in other organs than the brain.

Here I want to emphasize one very important point. If these babies bleed they bleed early. The vast majority of them bleed within the first forty-eight or seventy-two hours, and practically all of them bleed within the first week of life. Lespinasse [10] reported fifteen cases treated with transfusion, and all but two patients were less than 4 days old. The umbilical vein is patent and accessible up to 4 days of life, as demonstrated by my case.

MORTALITY

Before the use of human blood, the mortality in this condition was from 35 to 87 per cent.[3] Up to 1914, thirty-seven cases had been reported treated with human blood, either by injection under the skin, or by transfusion, or by both, with three deaths, or a mortality rate of 8 per cent. We now believe that all of them should recover if properly treated.

TREATMENT

Lucas and Dearing [11] by the vital dye method demonstrated that the blood volume in infants was about one tenth of the body weight. If we use this as a basis, an infant has 1 ounce of blood to each pint

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9. Townsend, cited by Cherry, T. H., and Langrock, E. G.: The Relation of Hemolysis in the Transfusion of Babies with the Mothers as Donors, J. A. M. A. **66**:626 (Feb. 26) 1916.

10. Lespinasse, V. D. (Footnote 8).

11. Lucas, W. P., and Dearing, B. F.: Blood Volume in Infants Estimated by the Vital Dye Method, Am. J. Dis. Child. **21**:96 (Jan.) 1921.

in the adult. If we bear this relationship in mind, we may better appreciate what the loss of a few ounces of blood means to an infant. Any bleeding in the new-born baby should put us on our guard to the extent of securing a donor in case an immediate transfusion becomes necessary. In any event it is advisable to give a subcutaneous injection of from 15 to 20 c.c. of whole blood and repeat this in six or eight hours. If there is any further evidence of bleeding, transfusion should be repeated. In the intestinal case, the external manifestation is no index of the amount of blood lost. The baby may become exsanguinated by bleeding into the intestinal tract, and only a small dark stool may be seen or even no stool at all. In these cases, immediate transfusion is the only hope.

It was once thought that the blood of the mother and of the infant were always compatible. Cherry and Langrock [12] tested thirty-four new-born babies against their mothers' blood. There was no agglutination nor any hemolysis in any of these tests. They started out to make 100 consecutive tests on as many babies born in the hospital, but they stopped when thirty-four gave no agglutination and no hemolysis.

According to the more recent work of Jones [13] on 197 specimens of blood from young infants, 78.8 per cent. could be placed in one of four groups in accordance with the classification of Moss. He showed that the different groups occurred with approximately the same frequency in the new-born infant as they do in the adult. Iso-agglutinins have been demonstrated in the blood of a 7 months' fetus.

In 1920 Minot and Weld [14] examined 160 specimens of umbilical cord blood and found that 70 per cent. could be definitely grouped.

Happ [15] established the group by both serum and cell reaction in 22.7 per cent. of infants between 1 and 3 months of age, in 31.8 per cent. of infants from 4 to 6 months, and in 69.7 per cent. of infants from 6 months to 1 year. He states that after one year the group could be established in practically every case.

Unless time will not permit, every patient should be tested against the donor for agglutination and hemolysis before the transfusion is performed. Of course, the Wassermann reaction of the donor's blood should be known.

The injection and transfusion of whole blood will accomplish these results: (1) stop the hemorrhage; (2) replace lost blood, and, (3) overcome infection by giving new antibodies and new complement.

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12. Cherry, T. H., and Langrock, E. G. (Footnote 9).
13. Jones, B. B.: Iso-Agglutinins in the Blood of the New-Born, Am. J. Dis. Child. **22**:586 (Dec.) 1921.
14. Minot, G. R., and Weld, M., cited by Jones, B. B. (Footnote 13).
15. Happ, W. M.: J. Exper. Med. **31**:313 (March) 1920.

REPORT OF CASE

A boy, well nourished and well developed, was born, March 5, 1919, at 3 p. m., after normal labor, at the end of the fourth pregnancy. The baby weighed 9 pounds. There was no cyanosis, no jaundice and no history of any hemorrhagic tendency in the family. Three other children were living and well.

Very soon after the delivery, a dorsal slit was made on the penis, and the attending physician went to town, 12 miles away. Four hours later, the nurse telephoned the physician that there was bleeding from the incision in the penis. The incision was sutured tight, and a number of local applications to stop bleeding were applied during the next thirty-six hours, but to no avail. The baby was brought to the hospital the second day in very poor condition. Bleeding from the dorsal slit incision continued; the baby was pale and looked as if he had lost considerable blood. He noticed very little that went on around him. He was given 15 c.c. of whole blood from the father. This injection was repeated in eight hours. At the time of the second injection, the bleeding had practically ceased. Twelve hours later the blood injection was repeated, though there had been no bleeding since the second injection. At this time the baby's blood showed hemoglobin, 25 per cent.; erythrocytes, 2,000,000; coagulation time, fifteen minutes. We were unable to determine the bleeding time. The baby had taken very little food and took water only by means of a medicine dropper. A transfusion of blood was decided to be advisable. The mother was brought to the hospital, and the baby was given 100 c.c. of whole blood by way of the umbilical vein. The cord was kept wet with a saturated boric acid solution for eight hours before the transfusion, or during the time required to bring the mother to the hospital and to perform the transfusion.

COMMENT

Obtaining blood from one of the superficial veins of the new-born infant is often a difficult task and at times even impossible in the hands of an expert. The easiest route is by way of the superior longitudinal sinus; but this route should be employed only by one experienced in its use, and even the experienced worker may fail to enter the sinus because of its abnormal position, due to distortion from molding of the head. This is especially true during the first few days of life. We must admit also that the cranial cavity cannot be punctured with impunity: calamity will sooner or latter ensue.

The psychic effect on the mother was one of the reasons for selecting another route than that by way of the superior longitudinal sinus in this case. I dare say that no mother could look on with impunity and see a needle thrust into her baby's head. To avoid this psychic effect on the mother, I chose this new and different route.

So far as I know this method has never been used before; but it appealed to me as a rational method for the baby had been receiving blood and nourishment through the umbilical vein exclusively until three days previously. I gave him 100 c.c. of blood through this channel. At the time I thought of the possibility of a clot in the umbilical vein; but I felt that its occurrence was unlikely in this type of case for we know that the blood from these patients remains in a

fluid state for a long time when withdrawn from the body and kept in contact with foreign substances. Since then I have performed necropsies in two cases of hemorrhagic disease of the new-born and dissected out the umbilical vein to its entrance into the liver. It was perfectly smooth and clean throughout; no blood was present.

METHOD OF TRANSFUSION

The umbilical cord stump, which was of the usual length, about 2 inches, was surrounded by a gauze dressing which was kept wet with sterile saturated boric acid solution. This was continued for eight or ten hours until the mother could be brought to the hospital. This kept the cord from becoming too dry.

The baby was placed on the operating table, and the umbilical cord was exposed. The cut end of the cord presented the two patent lumens of the umbilical arteries and the collapsed umbilical vein, the latter, the largest of the three openings. The cord was then cut just proximal to where it had previously been tied off. This gave a fresh cross-section of these three blood vessels. The regular "record" transfusion needle was inserted into the largest of these three vessels, the umbilical vein, and a ligature was tied over the cord to the needle to hold the needle in place. At this point a 20 c.c. record syringe was filled with physiologic sodium chlorid solution, and this was slowly injected into the umbilical vein. No resistance occurred and no obstruction was noted. An effort was made to withdraw the saline in order to see whether any sudden stoppage of the needle would occur, as the withdrawing of a clot into the needle. That was not noted. After this was done, it was felt that the vein was patent and that it was safe to proceed with the transfusion as planned. At this juncture the mother's arm was prepared as usual, and the median basilic vein was entered with a needle similar to the one used in the baby's vein. With the aid of an assistant who filled the 20 c.c. record syringes with blood from the mother's vein, I gave five 20 c.c. syringefuls of whole untreated blood direct from the mother's veins. After the fifth syringe was emptied in the umbilical vein, I injected 10 c.c. of physiologic sodium chlorid solution to rinse out the needle and the vein. The needle was then withdrawn from the umbilical vein, and the cord was again tied off as before.

If given earlier, this transfusion would have stopped the bleeding; but it was given primarily to replace the blood lost. It was believed that the baby had lost at least 4 or 5 ounces of blood and probably more. It was also believed that the baby was beginning his life with a considerable handicap, having lost probably a third or a fourth of his blood. To replace this lost blood would very probably make his first year uneventful. Following the transfusion, the hemoglobin increased to 80 per cent. and the erythrocytes to 4,500,000. He had a slight

chill and a rise of temperature to 103, two hours after the transfusion. The temperature fell immediately, and the baby made an uneventful recovery. He weighed 25 pounds at 12 months, 30 pounds at 2 years, and 38 pounds at 3½ years. He is normal in every way.

SUMMARY

This baby was transfused through the umbilical vein on the fourth day of life with the greatest ease. The fact that the great majority of cases of hemorrhagic disease of the new-born occur during the first three days of life should impress upon our minds the fact that if transfusion is necessary in these infants it may be performed through the umbilical vein with greater ease than by any other route. It is a common observation of Rodda,[16] Warwick[17] and others who have performed necropsies on the new-born that the blood remains fluid hours after death in most of these cases.

Lucas[18] showed that there is a definite prolongation of coagulation time in the first few days. He says, "There is a definite and fairly constant condition in the blood of the new-born which favors the so-called hemorrhagic condition of the new-born." He found the coagulation time prolonged as much as forty minutes. He believes that the new-born infant normally has a prolonged coagulation time, whether hemorrhage appears or not.

CONCLUSIONS

1. The umbilical vein may be patent and accessible for transfusion up to, and including, the fourth day of life.

2. The umbilical vein up to the fourth day is the most accessible vein in a new-born baby, if patent.

3. The probability of a clot in the umbilical vein is very unlikely because the blood is fluid many hours after death in these cases.

4. Transfusion through the sinus in cases of intracranial hemorrhage may increase intracranial pressure, which is not desirable.

5. Transfusion through the superior longitudinal sinus is comparatively simple for one experienced, while the umbilical route is simple for those inexperienced in the sinus route.

6. In my experience, the median basilic vein is always large enough to admit an 18 gage needle in infants as young as 2 or 3 weeks, and is preferable to the superior longitudinal sinus usually; but it is necessary to dissect it out.

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16. Rodda, F. C.: Determining Coagulation Time of the Blood in the New-Born, Am. J. Dis. Child. **19**:268 (April) 1920.

17. Warwick, M.: Necropsy Findings in New-Born Infants, Am. J. Dis. Child. **21**:488 (May) 1921.

18. Lucas, W. P., et al.: Blood Studies in the New-Born, Am. J. Dis. Child. **22**:525 (Dec.) 1921.

THE CAUSES OF ABSENCE IN A BOYS' SCHOOL*

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The study here reported was made at St. Paul's School,[1] and is recorded because data concerning the health of schoolchildren are always helpful. In Table 1 are summarized the diagnoses in the various cases, as given in the infirmary records, and the total number of days spent in the infirmary for three consecutive years.

There are several interesting points in this table that should be noted. In the first place it is quite evident that some of the conditions listed are closely related, and a sharp differential diagnosis is often impossible. This is particularly true of the first nine conditions, the respiratory tract infections. The diagnosis was made either from the outstanding condition on admission, or from the development of the disease during the illness. That is to say, if a boy came to the infirmary with coryza, but later developed bronchitis, the diagnosis was given as bronchitis; or if a boy complained of sore throat and later developed an infection of the middle ear, which overshadowed the primary condition, the diagnosis was given as otitis media. If, on the other hand, the chief complaint was coryza, and nothing further developed, the diagnosis remained coryza.

It is quite possible, also, that some of the cases listed under headache should be listed under some other heading, as constipation, sinusitis or fatigue. But in these cases no such causative condition could be found, and they had, therefore, to be classed according to the chief complaint on admission.

It is interesting to note that in many of the cases of indigestion there was a definite history of overeating, showing that this youthful indiscretion is an occasional cause of sickness. In the school year of 1919-1920, there were only two patients that gave such a history; but in 1920-1921 there were nineteen patients, or one third of the total number, causing a loss of fifty-six days. In the following year, there was exactly the same number of cases, with the same number of days lost as in 1920-1921. It is, no doubt, true that some of the other cases were due to the same cause, although no such history could be obtained.

The contagious diseases reveal several interesting points. The usual history of an epidemic of any of the contagious diseases is that it began

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1. A boarding school at Concord, N. H., for boys ranging in age from 11 to 18 years.

in a patient who had returned from a vacation. Occasionally, however, a case arises in the middle of a term, long after the incubation period has passed, and in which no source of contagion can be found. Except for an occasional visit to Concord (2 miles from the school) and an occasional visitor, the school is fairly well isolated, and the points of contact are reduced to the minimum. Within the school, however, the points of contact between boys are numerous, and whenever a case of a contagious disease occurs in the school the chances of exposure and spread are great.

TABLE 1.—NUMBER OF CASES AND TOTAL DAYS LOST

Cause	1919-1920		1920-1921		1921-1922	
	Cases	Days	Cases	Days	Cases	Days
Coryza	49	213	49	234	140	760
Tonsillitis	62	327	50	246	102	728
Pharyngitis	41	181	44	209	88	620
Bronchitis	25	189	23	138	31	227
Laryngitis	2	10	2	11	2	11
Grip	121	1,038	4	35	23	157
Pneumonia	1	24	1	13	1	15
Otitis media	16	172	19	171	38	306
Sinusitis	7	87	2	7	12	72
Headache	41	124	18	73	20	45
Indigestion	37	79	68	188	60	183
Constipation	..	..	4	8	8	22
Enteritis	1	3	5	8	5	14
Fatigue	11	28	8	34	13	35
Scarlet fever	13	454	2	67	1	31
Measles	34	566	..	...	..	..
German measles	1	12	..	...	..	..
Chickenpox	..	..	39	595	1	11
Mumps	..	..	19	354	1	14
Pertussis	..	..	15	86	1	21
Conjunctivitis	1	1	69	273	10	33
Adenitis	7	54	3	32	8	41
Dermatitis	1	5	..	...	4	20
Arthritis	1	5	..	...	1	10
Accidents	38	97	41	172	37	103
Observation	16	53	..	...	8	8
Miscellaneous	85	320	52	212	59	243

In the winter of 1919-1920, there was one case of rubella with no cases following. This term began January 17, and the patient came to the infirmary March 20. April 30, seven days after the beginning of the spring term, a case of scarlet fever and a case of measles were admitted, each undoubtedly brought back from vacation. Each of these resulted in an epidemic. There were thirteen cases of scarlet fever and thirty-four of measles.

The epidemic of chickenpox, the following year, began February 4, twenty-four days after the opening of school following the Christmas holidays. The epidemic of whooping cough calls attention to an error in the statistics. No record has been kept of the number of days lost by boys who went home on account of sickness. It is very evident that fifteen cases of whooping cough would make a total of more than eighty-six days' absence. This small number is due to the fact that

some boys went home as soon as a cough developed. The error, as noted in the case of pertussis, is not, however, a large one.

There were two cases of scarlet fever in this year, both occurring in the spring term. The first case entered the infirmary May 17, exactly five weeks after the opening of school, and it was impossible to find any exposure to any other case. May 23, another case occurred in a boy who, as far as could be determined, had not been in contact with the first patient. He lived in a different dormitory, went to a different dining hall, and was not associated in class room or athletic field.

During the year 1921-1922, one case each of chickenpox, scarlet fever, whooping cough, and mumps developed, all of them occurring in the spring term. This term began April 5. The case of rubella was admitted April 7; the case of mumps, April 26; chickenpox, May 20, and scarlet fever, May 23. In the last two, the incubation period was passed, and no source of contagion could be found.

The miscellaneous group includes a number of conditions which occurred infrequently or were unimportant from a health standpoint. This group contained in 1919-1920 a case of myositis ossificans, one of endocarditis, one operation for appendicitis, one case of eczema, one of sunburn, two cases of boils, two of catarrhal jaundice, and several cases of "abdominal pain." The last named were indefinite conditions, and possibly should be called indigestion. The miscellaneous group in the other years is similar.

In view of the fact that some of these conditions are allied and sometimes difficult of accurate differential diagnosis, a much better grouping would be that found in Table 2, under the headings "Respiratory Tract Infections," "Contagious" "Gastro-Intestinal" and "Miscellaneous."

The data presented in Table 2 are expressed graphically in Table 3, which is similar to the one given by Dr. Mason [2] in his studies at the Lincoln School.

Tables 2 and 3 show that respiratory tract infections were the chief cause of sickness, the contagious diseases being next. This condition was, however, reversed in 1920-1921. The studies at Lincoln School revealed a similar situation. Dr. Richard Smith,[3] in a study at River's School, Brookline, Mass., also demonstrated that the respiratory infections were the chief cause of loss of time, although the minor illnesses caused more absences than the contagious diseases. The percentage of days lost from all causes at River's School was 9.6. At the Lincoln

2. Mason, H. H.: Some Records Regarding Absences and Their Causes in the Lincoln School of Teachers College, Am. J. Dis. Child. **22**:500 (Nov.) 1921.

3. Smith, R. M.: Health Study of a Boys' School, Am. J. Dis. Child. **18**:246 (Oct.) 1919.

School the percentage dropped in four consecutive years from 14.9 to 8.6. It is probably not fair to compare these studies too closely, the other two being made in day schools, whereas St. Paul's is a boarding school. It is interesting, however, to note the similarity in the studies, and that in all three studies the respiratory tract infections were the chief cause of loss of time.

TABLE 2.—AMOUNT OF TIME LOST AS A RESULT OF VARIOUS CAUSES

Cause	Amount of Time Lost								
	1919-1920			1920-1921			1921-1922		
	Cases	Days	%	Cases	Days	%	Cases	Days	%
Respiratory infections	282	2,060	2.27	150	855	0.91	349	2,277	2.39
Gastro-intestinal	38	82	0.09	72	204	0.21	73	219	0.23
Contagious	48	1,032	1.14	75	1,102	1.16	4	77	0.08
Miscellaneous	201	687	0.75	191	796	0.85	160	539	0.57
Total	570	3,861	4.26	488	2,957	3.15	586	3,112	3.24
Total possible attendance		90,440			93,852			95,274	

TABLE 3.—PERCENTAGE OF TIME LOST FROM VARIOUS CAUSES

	1919-20	1920-21	1921-22
Total possible attendance (days)	90,440	93,852	95,274
Total days lost	3,861	2,957	3,112
Days lost, respiratory (per cent.)	2.27	0.91	2.39
Days lost, gastro-intestinal (per cent.)	0.09	0.21	0.23
Days lost, contagious (per cent.)	1.14	1.16	0.08
Days lost, miscellaneous (per cent.)	0.75	0.85	0.57
Total days lost (per cent.)	4.26	3.15	3.24

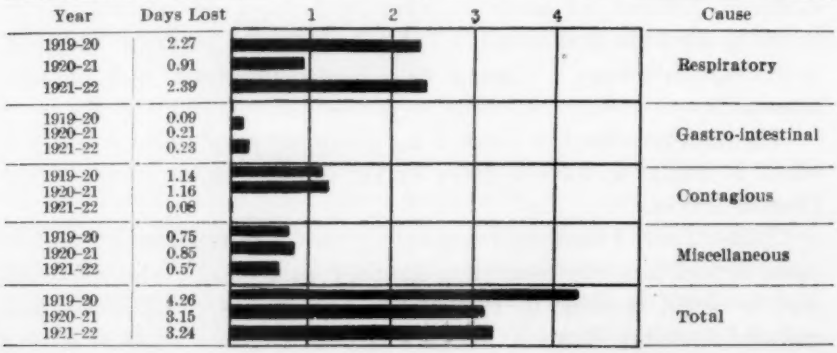
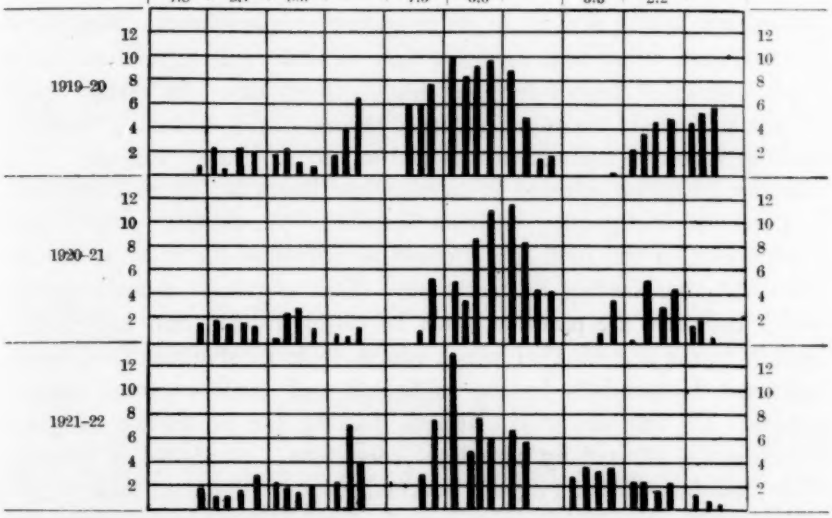


Table 4 shows the percentage of absences month by month and week by week. In calculating the figures for this table, the number of boys in attendance each day was used, a boy who went home was considered as being dropped temporarily. In order to check the accuracy of these figures, the total enrolment was used, and in no case was the difference in them more than one tenth of 1 per cent., so that the error caused by boys who went home is slight, and the figures given are quite accurate.

Table 4 shows at a glance the marked increase in sickness during the winter term, and, except in 1920-1921, a noticeable increase with the onset of cold weather at the end of the fall term. This high rate has been due largely to the respiratory tract infections. In February, 1920, the high rate was due almost entirely to this cause, there being 1,118 days lost, of which only fifty were lost from the other causes.

TABLE 4.—PERCENTAGE OF TIME LOST, MONTH BY MONTH AND WEEK BY WEEK

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Average
1919-20		2.3	1.9	1.8		10.0	8.9		2.3	4.5	
		0.4	2.3	4.0	6.0	8.3	4.9		3.8	5.4	4.2
		2.3	1.3	6.5	6.0	9.3	1.5		4.4	4.9	
	0.7	2.0	0.9		7.9	9.9	1.6	0.06	4.8		
1920-21		1.8	0.3	0.8		5.2	11.6		0.6	1.5	
		1.4	2.1	0.5		3.8	8.1		5.1	1.8	3.15
		1.7	2.6	1.3	1.1	8.6	4.3	0.69	3.0	0.43	
	1.7	1.4	1.1		5.4	11.0	4.1	3.5	4.3		
1921-22		1.0	2.2	2.1		13.0	6.8	2.8	2.3	1.3	
		1.0	1.8	7.0		4.9	5.8	3.4	2.3	0.7	3.24
		1.4	1.4	4.0	3.0	7.8		3.2	1.7	0.3	
	1.8	2.7	2.0		7.5	6.0		3.3	2.2		



The increase during the winter of 1920-1921 was due partly to an epidemic of conjunctivitis and chickenpox; but in 1921-1922 it was due almost wholly to respiratory infections. During the first week in February (the highest point in the three years), there were fifty-eight cases admitted to the infirmary, all but five of them being cases of infection of the respiratory tract.

A study of this kind shows at a glance the chief causes of sickness, and indicates also where the chief emphasis must be placed in an attempt to reduce the rate of sickness. It would be a great help to those engaged in this kind of work if further studies, particularly in the same type of school, were available.

THE SALIVA OF THE NURSLING*

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Investigations of the saliva of the nursling deserve attention from both the scientific and the clinical points of view. Saliva is readily obtained for experiment in the pure state, and a knowledge of its properties is valuable in reaching conclusions concerning the digestive fluids in general. The importance of saliva in gastric digestion is greater than has heretofore been assumed.

We have studied the saliva of the nursling under both physiologic and pathologic conditions. Before describing our experiments and conclusions, something should be said of the present knowledge of the subject. The reaction of the saliva of nurslings is normally alkaline to litmus, but nearly neutral in electrometric measurements. Reports in the literature of alterations from hour to hour, and in relation to the requirements of digestion show much discrepancy. In certain more or less pathologic states the reaction becomes acid, including ordinary decomposition in the contents of the mouth in healthy subjects. The quantity of saliva secreted in twenty-four hours is (up to 2,000 c.c.) in excess of the quantity of urine secreted. Mastication, some of the constituents of the food and condiments stimulate the flow, as do also stomatitis, the cutting of teeth, etc. The so-called albumin glands, which comprise the parotids, must be distinguished from the mucous glands, in the secretion of which mucin replaces albumin, these being represented essentially by the sublingual and small scattered mucous glands. The albumin glands secrete diastase, the production of which is not much affected by pathologic conditions. In regard to innervation, stimulation of the cranial nerves causes an abundant flow of thin saliva, while stimulation of the cervical sympathetic nerve causes an increased secretion of mucus. Reflex irritation of the buccal mucous membrane, acting through a reflex center in the medulla, may also modify both the amount and composition of the saliva. This center is connected directly with the cerebral cortex.

The saliva of the nursling is quite a modern subject for investigation compared with saliva in general, the study of which was undertaken by Simon in 1842 and Wright in 1844. The reaction of the

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* From the Orphans' and Children's Asylum of the City of Berlin, Director, Prof. L. F. Meyer, M.D.

saliva at birth is a subject concerning which there have been conflicting statements, dependent, no doubt, on the use of different indicators. If the mouth is first irrigated to rid the cavity of extraneous matter, the reaction is said to be alkaline, or at most neutral—never acid. By the electrometric method the reaction appears to be approximately neutral, but not absolutely neutral, being either slightly acid or slightly alkaline.

It was once denied by several pediatricians that the new-born baby secreted any saliva, and again it was asserted that the salivary glands could function in utero. But it is now generally held that at, and after, birth, a small quantity of saliva is secreted up to about 6 weeks. After that period there is a steady increase, and at from 3 to 4 months a considerable quantity can be collected for experiment. Later the cutting of the first teeth appears to cause a considerable increase, the saliva dribbling continuously.

The presence of saliva in the early weeks of life does not imply that it is a digestive secretion at that period, and it has been denied that ptyalin is present until after the first 6 weeks. This statement is probably untrue, for a number of independent investigators have found enzyme present at birth. Moll found enzyme in a 7 months fetus, while Ibrahim discovered it in all three of the large salivary glands in 8 and 9 month fetuses. It has been shown that the proportion of enzyme increases during the first year, while after that period there is no further increase. The saliva of a child, aged 1 year, does not, in other words, differ from that of an adult. Finzi has shown that up to the age of 6 months the starch content of the food does not exert any influence on the diastatic strength of the saliva. Later the results in this province are conflicting.

EXPERIMENTAL RESULTS

Reaction.—We have made more than 100 determinations on fifty-five nurslings. In all cases the saliva was collected by aspiration during a period of fifteen minutes. The aim of the research was to establish standard values for the normal nursling. The method was this: A flexible metal aspirator, perforated with four circular openings, each about one-tenth centimeter in diameter, was used, as dentists use it, in both cheek pockets, being moved to and fro, while suction was employed with a syringe of 100 c.c. capacity. The aspirated saliva was collected in a graduated measuring glass. The interval of fifteen minutes was prolonged if the saliva was slow in accumulating. In the latter case the accumulation of the first fifteen minutes was recorded.

The amount of saliva thus obtained was read and recorded, and the reaction was first taken with a one-color indicator, usually metanitrophenol. If the test fluid was turbid, it was controlled with an indif-

ferent fluid of the same turbidity. The content of ferment was determined by the Michaelis-Pechstein[1] method. Four Erlenmeyer flasks were filled with the following solution:

5	c.c. Kahlbaum's 1 per cent. soluble starch
20	c.c. sodium chlorid solution, fiftieth normal
3	c.c. of ⅓ primary phosphate[2]
0.30	c.c. ⅓ secondary phosphate[3]
5.7	s.c. water.

The sodium chlorid is added because salivary diastase is entirely inactive in the absence of salts. The latter can combine with all possible salts to form double combinations, each of which has characteristic peculiarities. The diastatic activity depends on the affinity of the salts for the diastase, i. e., on the completeness of the union, and on the extent of the activity on starch. The addition of sodium chlorid prevents errors in consequence of fluctuations in saline content of the saliva and guarantees the preparation of a favorable and always uniform combination of the diastase.

The necessity for the addition of the phosphate solutions arises from the fact that the reaction must be established in all ferment studies. To each of the four flasks containing the starch mixture is added 1 c.c. of saliva. In the first there is no dilution; in the second the dilution is 1 part of saliva to 1 part of water; in the third, 1 part of saliva to 3 parts of water, and in the fourth, 1 part of saliva to 7 parts of water. The duration of the test was twenty minutes at room temperature. The diastatic action was interrupted by the addition of 20 c.c. of a hundredth normal solution of iodin, when by complete hydrolysis of the starch the solution became light yellow, in other words it was colored only by the iodin. If partially red, from the presence of erythrodextrin, the cleavage is incomplete, while if the color is a deep blue the starch is not yet affected by the presence of the ferment. For the estimation of the ferment content the amounts of saliva were ascertained, in which, under conditions already described, complete cleavage of starch appears, or, in other words, until the red color is no longer in evidence. If 1 c.c. of undiluted starch is necessary, the ferment content is valued at 100. If 1 c.c. had been diluted to make 5 c.c., with complete cleavage, the valuation would be 500.

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1. Michaelis, L., and Pechstein, H.: Biochem. Ztschr. **59**:77, 1914.

2. The formula for ⅓ primary phosphate is: 100 c.c. of a 10 per cent. solution of sodium hydroxid; 100 c.c. of a 10 per cent. solution of phosphoric acid, and 100 c.c. of water. Of this solution 3 c.c. is put in each flask.

3. The formula for ⅓ secondary phosphate is: 200 c.c. of 10 per cent. solution of sodium hydroxid and 100 c.c. of 10 per cent. solution of phosphoric acid. Of this solution 0.3 c.c. is put in each flask.

RESULTS

The reactions obtained in our experiments were strikingly constant. There were never more alkaline values than $p_H = 7.8$, or more acid values than $p_H = 6.8$. The highest acid values were found in a few tests in which the amount, having been too small for testing, had been diluted with water from fourfold to sixteenfold. The least dilute, from one and one-half to threefold, showed a p_H varying from 7 to 7.8. Electrometric controls with saliva diluted from 1:2 to 1:4 showed practically absolute agreement with colorimetrically obtained values. It is probable that the slight variations in reaction were really less than they seemed. That the alkaline value of $p_H = 7.8$ was obtained only by the colorimetric method in consequence of a defect in the indicators is hardly to be assumed. Therefore, the concentration of the saliva seems to have been too slight. Probably, however, the most acid value ($p_H = 6.8$) is too high, for it was found only in strong dilution with distilled water, with a p_H of about 6.7. With the slight concentration of the buffer salts in the saliva, with fourfold and stronger dilution, the native reaction of the saliva would be suppressed by the reaction of the water. In the future, attention must be paid to this circumstance, and, through the employment of freshly boiled water, it may be readily met. Hence in our experiments the reaction of the saliva in the nursling varies between 6.8 and 7.8 p_H and probably between 7 and 7.8. With this slight variability it is unlikely that any relationship can be found between p_H and the time of day, ingestion of food or condition of the child. Such studies, moreover, have to be opposed to technical difficulties. The very cases in which change of reaction is soonest to be expected would be in the very young and very sick nursling, in whom there is so little saliva produced that dilution would lead to errors.

As a result of our experiments we are able to establish the following facts: The saliva of the nursling, under normal and pathologic conditions, varies between slightly alkaline and neutral. Our results, therefore, deviate but slightly from those of Allaria,[4] while there is complete agreement with the latter in regard to independence of the reaction to the condition of the child. The reaction of the saliva is a function of its content of carbon dioxid and alkaline carbonate; it is proportional to the concentration of both. In theory we may assume that more alkaline values could be obtained if special measures were not taken to prevent the loss of carbon dioxid.

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4. Allaria, G. B.: Die chemische Reaktion des Säuglingsspeichels, Monatschr. f. Kinderh. **10**:179, 1911; Ueber die Wirkung des Speichels im Anfangsstadium der Verdauung beim Säugling, Jahrb. f. Kinderh. **74**:252, 1911.

In order to prevent the loss of carbon dioxid Bloomfield and Huck recommended that the saliva be collected under a stratum of oil. According to Starr [5] the increase of alkalescence which results from the loss of carbon dioxid amounts to 0.20 p_H. In our own investigations precautions of this sort were not taken because, with the syringe method of collecting the saliva, the carbon dioxid loss was unavoidable. This slight error in any case is not sufficient to prejudice our results.

The reaction of the saliva is, according to our measurements, but little different from that of the blood, which is normally between 7.3 and 7.5. This is readily understood, for undoubtedly the alkaline carbonate of the saliva as well as the carbon dioxid are derived from the same ingredients of the blood. Starr has even shown a proportional relation of p_H in the saliva of the adult and the carbon dioxid of the alveolar air. Is the reaction of the saliva in the nursling identical with that of the adult? It is difficult to answer this question because the findings in the adult show such lack of harmony. The authors, as Michaelis and Pechstein,[1] were unable to find any differences worth mentioning, but Starr [5] has found higher acid values in the adult, although only with an uncontrolled colorimetric method.

The constancy of the reaction of the saliva is noteworthy. In the urine and gastric juice the acidity shows great fluctuations, as this is inevitable for the maintenance of the constancy of the reaction of blood. Such fluctuations are, therefore, a criterion of renal sufficiency. Fluctuations in the acidity of the stomach contents are due chiefly to alterations in the amount of gastric juice secreted. What is then the explanation of the constancy of the salivary reaction? The answer which first suggests itself is that a certain reaction is necessary to activate the salivary ferment. According to Michaelis and Pechstein, the optimum reaction for the diastase is $p_H = 6.7$. It is true that the food soon enters the stomach and that salivary digestion largely takes place there.

Amount of Saliva.—For the normal nursling at the age of from 1½ to 3 months the amount of saliva collected during the fifteen minute intervals varied from 1.3 to 2.2 c.c., or an average of 1.6 c.c. In older nurslings, say from 5 to 8½ months of age, the amounts for the same time intervals varied from 2.5 to 8 c.c., with an average of 4.8 c.c. In the sick nursling the first to be studied were the victims of mild infections, in which cases twelve investigations were made. Only three times was an alteration found beyond the likelihood of error.

5. Starr, H. E.: Studies of Human Mixed Saliva: I. The Determination of the Hydrogen Ion Concentration of Human Mixed Saliva, J. Biol. Chem. **54**:43 (Sept.) 1922; Studies of Human Mixed Saliva: II. Variations in the Hydrogen Ion Concentration of Human Mixed Saliva, ibid. **54**:55 (Sept.) 1922.

Two of these infants had whooping cough with bronchitis, and in each of them the figure was 1.5 c.c., the age being 6½ months. The third subject, a child 5 months old, with glossitis, showed an increase of a pronounced character, 10 c.c.

Sixteen nurslings with severe infection were next studied, and in all but one a considerable alteration was found. The exception was an infant, aged 2½ months, the ailment being bronchitis and the amount of saliva 1.6 c.c. In some other cases reduction of amount was so great that no saliva could be obtained, as in two children, 1 month old, with influenza. In two others, aged, respectively, 6 and 7½ months, with severe toxi-infectious processes, the amount collected was, respectively, but 0.2 and 0.4 c.c. Finally, in a child aged 6 months, with bronchopneumonia and pyelitis, the amount was 1 c.c. Eleven nurslings with acute disturbance of nutrition were then studied. During and just after the acme, there was a considerable diminution in the quantity; but afterward, say three weeks later, this had regained the normal limits. One infant, aged 1 month, with acute indigestion had no saliva at all; one of 5 months showed 0.7 c.c.; a third, aged 11½ months, had 1.5 c.c. eight days after treatment with withdrawal; a 5 months' nursling with acute indigestion showed 2.5 c.c. although in a parallel case after fourteen days the amount was but 1 c.c., and finally in a child, aged 1 year, two and one-half weeks after withdrawal treatment, the amount was 2 c.c.

In chronic disturbances of nutrition nineteen investigations were made and a distinct diminution of the amount of saliva noted. As a rule this was less pronounced than in the acute cases and in the severe infections. The diminution was more marked in the infants who were severely affected than in the mild cases. Thus, in a dystrophic nursling, aged 2 months, the amount was 0.6 c.c.; in a 5 months' old dystrophic child, it was 1 c.c., and in a 10 months' old child, 2 c.c.

Diastase.—In regard to the salivary diastase young normal nurslings of ages ranging from 1½ to 3 months (four investigations), the majority showed a ferment strength of between 300 and 600. One case each fell above and below these limits. Thus a 1½ months' old healthy nursling showed as high as 1,200, while in a sound 2 months' old child the very low figure of 60 was reached. The average was 475.

In older healthy nurslings, with age limits of 5 to 8½ months (twenty-one investigations), the ferment content was higher, usually between 600 and 1,600. In this series also there were two exceptions. In one child, aged 6½ months, the low figure of 100 was present, while at the other extreme the 8½ months' old infant gave the figure 4,800. The average of the series was 1,200. Hence there is a not inconsiderable difference in ferment strength in both older and younger nurslings,

which may be set down rather to difference in the number of glands than to a greater or less amount of saliva, this being easily excluded by measuring the latter.

In regard to the amount of diastase in diseased nurslings, a study of twelve infants with mild infections showed that in but one was there a departure from the customary. In a child, aged 2 months, with an added diarrhea, the ferment strength was but 25.

Of fourteen examinations of severely infected infants, six gave positive results which were outside the possibilities of error, in which the normal ferment strength was diminished. Usually these cases occurred in the older nurslings with severe toxi-infectious disease; for example, in two of them the low figure of 50 was reached. In this series reduced ferment strength coincided with reduced quantity. In two patients failure to obtain any saliva naturally prevented making the test for ferment strength.

In acute disturbances of nutrition (eleven investigations) one nursling was without any saliva for examination. Of the others, two, aged 5 months and 11½ months, respectively, with acute dyspepsia, showed no reduction of ferment strength despite reduction in amount. The same may be said of most of the remainder. In but one case, that of a 2 months' old nursling tested two weeks after an acute attack, the ferment strength was reduced to 50. In this series convalescence was evidently more or less advanced at the time of examination. Generally speaking this series, which was really too small for conclusions, exhibited reduced amount without reduction of ferment strength. Further studies of the quality of the saliva in these patients are already under way.

Nineteen nurslings with chronic disorders of nutrition were studied, and of this number seven, or about two-fifths, showed an undoubted diminution of ferment content, usually about 50. In five cases this was associated with diminution of quantity of saliva. In two the latter was within normal limits. Of the remainder, twelve in number, eight showed normal ferment content with diminished quantity.

SUMMARY

Active saliva occurs in the youngest nurslings tested (1 month old). Both the amount of saliva and the ferment concentration tend to increase with age, the quantity showing less range of fluctuation than the ferment content. In the disease conditions studied, the amount was more frequently and more intensively affected than the ferment content. Alteration in amount save in a single case of stomatitis was always in the direction of diminution. The coincidence of small amounts with normal ferment content was more common than that

of normal amount with lessened ferment content. In mild infections diminution of quantity was seen only in individual cases, but in severe infection that notably prejudices the organism — pneumonia, severe pyelitis—this diminution is almost constant. This is true alike of both acute and chronic infections. Chronic disturbances of nutrition affect the organism in this respect as do severe infections, while in acute types of the same disorders, only isolated examples of diminished quantity are encountered. In the chronic forms, both quantity and ferment content show diminution, while in the acute it is the amount rather than ferment content which is reduced.

There is a relative independence in the amount of saliva and ferment content, which as already stated, may be best explained by postulating a difference in the number of individual glands for each subject with the addition of a complicated nervous mechanism. In acute febrile conditions, however, the loss of water by the skin could in theory reduce the amount of saliva.

A BACTERIOLOGIC STUDY OF ACUTE DIARRHEAS IN YOUNG CHILDREN*

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Among infants there is a distinct seasonal incidence of disease. At the Babies' Hospital, to which contagious diseases are not admitted, the character or type of the ward cases varies with the seasons, although the quantity (numbers and severity) varies from year to year. Thus, for example, the number of cases of pneumonia increases from early fall until late winter, to be followed by empyema and then in the early spring by tuberculosis. The late spring is a hang over season for tuberculosis and empyema, and in the early summer the intestinal diseases begin to appear. There are few of these in June; they increase in number through July and August, and diminish after the middle of September. Frequently, however, the severest intestinal lesions are found at necropsy in October, among children whose illness has lasted five or six weeks or who give a history of mild diarrhea earlier in the summer. By November the ward for intestinal diseases is practically empty, and pneumonias have reappeared. Of course, there are cases of respiratory infection in summer and intestinal infection in winter, but the great majority of these appear in their proper season. It has been noted during the last few years that the cases of intestinal disease which come to necropsy present less severe lesions than were found ten or fifteen years ago. Since no bacteriologic study of the summer cases had been made for some time, a systematic study during the summer of 1922 was undertaken.

A ward was set aside for patients with infectious diarrhea, and special nurses were put in charge. All possible danger of carrying infection to the other wards was guarded against by precautions which were observed by the nurses and physicians entering this ward, and by special care given the linen and utensils used by the children. Diapers were made of gauze and were destroyed by burning.

The study was continued from June 5 to September 15. One hundred and thirteen bacteriologic examinations were made on eighty-six children; twenty-five were studied twice and two were examined

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* From the Babies' Hospital of the City of New York.
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three times. In addition, postmortem intestinal cultures were made in ten cases. The patients ranged from 6 weeks to 4 years of age. Sixty-eight were less than 1 year old, and only three were more than 3 years of age.

TECHNIC

Specimens of intestinal contents for bacteriologic examination were obtained with the proctoscope and a long sterile swab. Occasionally a child was too ill to be carried to the dressing room for examination. In such cases a sterile tube was introduced into the rectum and a specimen obtained without disturbing the patient. The proctoscope used at the hospital has been described by Drs. Spence and McLean.[1] The instrument is introduced to a distance of 6 inches without difficulty, and with no pain to the child, even the youngest. The mucosa of the rectum and lower sigmoid can be seen and the following points noted: the color of the intestinal lining; its appearance, whether smooth or granular; the amount of mucus; the bleeding points; the presence or absence of ulcers; the character of the bowel contents, and the presence or absence of tenesmus. A long sterile swab is introduced through the proctoscope, and the material obtained directly from the rectal mucosa is plated immediately on Endo plates. Kligler's [2] modification of this medium, using less of the sulphite-fuchsin mixture, 0.5 instead of 1.0 c.c., was employed.

From this point on our technic followed closely the directions laid down in the circular on diagnostic examinations issued by the New York State Board of Health,[3] a copy of which had been kindly furnished by Miss Kirkbride. All gram-negative, nonmotile, non-gas forming bacilli which agglutinated with polyvalent antidysentery serum were studied further in the following sugars, using the Andrade indicator: dextrose, lactose, mannite, maltose, saccharose and dulcite. The fermentation of mannite served to differentiate the Shiga bacillus from the Flexner group, and the fermentation of maltose served to differentiate the so-called Flexner from the Mount Dessert strains within the group of mannite fermenters. A few strains fermented saccharose. We found this differentiation at least as clear cut as that obtained by means of the five serums of the Murray subgroups V, W, X, Y and Z.

Finally, agglutinations were made with the three (Shiga, Flexner and Mount Dessert) specific antidysentery rabbit serums furnished by the New York State Laboratory, and the type of bacillus determined.

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1. Spence, R. C., and McLean, S.: Method of Obtaining Direct Cultures from Intestinal Ulcers in Infants and Young Children, J. A. M. A. **75**:742 (Sept. 11) 1920.
2. Kligler, I. J.: J. Exper. Med. **28**:319 (Sept.) 1918
3. New York State Department of Health, Form 18, 1921.

Further agglutination studies with all the mannite fermenting cultures were made in the serums of the subgroups V, W, X, Y and Z.

The intestinal cultures from twenty of the eighty-six children, when examined for dysentery bacilli, gave positive results. The cultures from three children showed the presence of the Shiga type of bacillus; five showed the Flexner type, and twelve the Mt. Dessert type. These groups will be discussed separately. Of the eighty-six children, thirty-two were clinically diagnosed as not having dysentery. Therefore, while 20⅓ per cent. of all cases examined were positive for *B. dysenteriae*, 37 per cent. of the cases presenting the clinical symptoms of dysentery were positive.

Infection with Shiga Type of Dysentery Bacillus (Three Cases).—In this country, infection with the Shiga bacillus is rare, and the group is the smallest in our series. The three patients harboring this type of dysentery organism were 5 months, 6 months and 2 years old, respectively. The youngest infant in the group left the hospital against advice, unimproved. The eldest of the three children died after an illness of four weeks. On proctoscopic examination during life, several ulcers were seen in the upper part of the rectum, and at necropsy one week later an ulcerative and pseudomembranous colitis was found. The third child of this group, who was 6 months old, recovered after an illness of two weeks' duration and of moderate severity. Her intestinal mucosa, seen through the proctoscope on the sixth day of illness, was deeply congested, covered with glairy mucus and showed many capillary bleeding points. The dysentery bacilli were no longer present in the stool one week after the first positive examination.

All three of these patients were treated with antidysentery serum made by the New York State Board of Health.

Infection with Flexner Type of Dysentery Bacillus (Five Cases).—This group was composed of three infants less than 1 year old, and two children who were 2 years of age. Two of the patients recovered, 11 months and 2 years of age, respectively; two died, and one left the hospital against advice, in an unimproved condition. Ulcers were seen through the proctoscope in the intestinal lining of one of the children. Two others showed deep congestion with bleeding from many points around swollen follicles, and two were too ill to be examined.

The illness of the five children in this second group lasted from five days to two weeks. Blood was present at some time in the stools of all five. Serum therapy was administered to the entire group.

Infection with Mount Dessert Type of Dysentery Bacillus (Twelve Cases).—The twelve children comprising this, the largest of our groups, were between 3 months and 4 years of age. Four of them recovered;

two improved; five died and one was removed against advice, unimproved. Nine patients were examined with the proctoscope. Ulcers were seen in four cases. In four others the rectal mucosa was congested and bleeding. In one a normal intestine was demonstrated. This little girl, 11 months old, had a mild diarrhea and was but slightly ill. The stools never contained blood, and clinically her case was not classed as dysentery. The positive laboratory findings came as a surprise.

It should be noted that blood in the stools does not necessarily mean ulceration of the intestine. The intensely congested mucosa bleeds readily even when no loss of substance has occurred.

The fatalities in this group occurred after an illness of from four to six weeks, while recovery took place after from two to three weeks. Serum was administered to all the children in this group that recovered, to one child that improved and to three of the five children that died.

The patients that are removed from the hospital in an unimproved condition are practically always hopelessly ill, and the parents' plea that "the child be allowed to die at home" cannot be denied. Therefore, such cases must be classed with those that died. It will be noted that, as is usual, the Shiga group of dysentery infections was accompanied by the highest number of fatalities, 66⅔ per cent. The Flexner group had a mortality of 60 per cent., and in the Mount Dessert group 50 per cent. of the patients died.

Ulceration occurred in 33½ per cent. of the Shiga and Mount Dessert types of infection and in 20 per cent. of the Flexner type. The severest and most extensive intestinal lesions and the longest course were found among the Mount Dessert group.

To sum up, while Shiga bacillus infection was accompanied by a higher mortality rate than was either of the mannite fermenting types of dysentery bacillus, it seemed to run a slightly shorter course. This is in keeping with the comparatively rapid disappearance of Shiga bacilli from the stool as noted by several observers.[4] Prolonged illness, longer than four weeks in duration, was more frequent in the mannite fermenting types of dysentery infections; and such prolonged cases were accompanied by severe and extensive intestinal lesions. These lesions were pseudomembranous and ulcerative in type, involving all of the large intestine and the last 30 cm. of the ileum. In our experience such an extensive necrotic lesion does not occur early in the disease.

SERUM TREATMENT

Antidysentery serum was administered to seventeen of the twenty children infected with the dysentery bacillus. Seven recovered; six died; one improved, and three were removed from the hospital before

4. Mackie, F. P., and Trasler, G.: Indian M. Gaz. **57**:85 (March) 1922.

the treatment was completed. The serum was administered intramuscularly in most cases, subcutaneously in some, and intravenously in one instance to a very sick child. Four doses of 20 c.c. each were usually given. The immediate effect of the serum was not remarkable, in that neither the fever nor the toxic symptoms were acutely influenced. No child treated without serum recovered, but one such patient improved. The serum treatment was begun on the third to the sixth day of the illness of the seven children who recovered, and on the fourth day in the case of the child who improved before she was removed from the hospital. In three of the fatal cases serum treatment was begun on the first, third and fourth days of the disease, and in the other three it was delayed until the seventh and fifteenth days. The children who left the hospital against advice were treated with antidysentery serum on the first and second days and in the third week of the attack of dysentery. It may be said, then, that while the administration of antidysentery serum in the first days of the disease does not always effect a cure, its delay until the second week is fatal. In other words, while eight of thirteen children to whom the serum was given, on or before the sixth day of an attack of dysentery, recovered, four children who received the serum later than the seventh day died. The series is a small one, with suggestive but not decisive results.

The total death rate for the twenty dysentery cases was 40 per cent. Adding the unimproved cases of patients who undoubtedly died to the known deaths, 55 per cent. of the patients in the series died, and 45 per cent. recovered. Bernstein, Kling and Rosenblatt,[5] from their experience in the Vienna epidemic of 1920, state that serum therapy of dysentery patients does not prevent the development of the chronic stage of the disease, nor influence the severely toxic cases. Lantin,[6] from his experience with dysentery in the Philippines, believes that without serum therapy the mortality rate is increased. Josephs and Davison[7] noted no difference in the course or mortality rate among twenty children treated with antidysentery serum.

It was planned to examine the stool before discharging the children, in order that no positive carrier should be sent out of the hospital. Dysentery bacilli had disappeared on the seventh, eighth, tenth and eleventh days of the illness, in four cases, and were still present in the stool on the thirteenth day in one instance.

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5. Bernstein, S., Kling, D., and Rosenblatt, S.: Wien. klin. Wchnschr. **34**: 531-549, 1921.

6. Lantin: Philippine J. Sc. **19**:629, 1921.

7. Josephs, H. W., and Davison, W. C.: Serotherapy of Bacillary Dysentery in Children, J. A. M. A. **77**:1863 (Dec. 10) 1921.

AGGLUTINATION REACTIONS

The sharp serologic distinction between the Shiga and the mannite fermenting types of dysentery bacilli was made very clear by agglutination reactions with the polyvalent and the specific antidysentery serums. These reactions also brought out the close relationship between the Flexner and the Mount Dessert groups of dysentery bacilli.

The three strains of Shiga bacilli isolated from children in the first group failed to agglutinate in polyvalent antidysentery serum in dilutions above 1 to 800, and in the Flexner and Mount Dessert serums in dilutions above 1 to 50. Three of the Flexner strains and four of the

AGGLUTINATION OF MURRAY SERUMS BY STRAINS OF MANNITE FERMENTING DYSENTERY BACILLI ISOLATED IN THE COURSE OF THIS STUDY

Strains	Serums								
	Polyvalent	Shiga	Flexner	Mount Dessert	V	W	X	Y	Z
Shiga (control)....	3,200	6,400	100	100					
A M	800	1,600	25	50					
D H	400	3,200	0	50					
J J	400	3,200	50	50					
Flexner (control)..	6,400	200	6,400	3,200	1,600	1,600	200	0	1,600
J P	100	100	100	50	200	0	0	800	200
D N	6,400	200	3,200	800	0	0	0	0	100
F W	800	100	800	200	200	1,600	100	0	200
M N	3,200	0	1,600	800	0	0	400	0	0
A T	6,400	0	3,200	800	0	100	100	0	0
Mount Dessert (control).....	6,400	0	3,200	6,400	100	0	800	100	0
K F	6,400	0	3,200	6,400	400	1,600	3,200	1,600	200
H N	3,200	0	800	3,200	0	0	100	0	100
J B R	400	0	200	25	100	0	0	100	0
J B I	800	100	100	800	400	800	800	1,600	200
C A	6,400	100	1,600	3,200	0	0	200	0	0
T A	3,200	0	800	1,600	400	0	800	0	0
T F	6,400	100	800	3,200	800	800	400	1,600	1,600
J B E	6,400	0	400	6,400	800	12,800	800	800	200
M R	1,600	0	400	1,600	400	1,600	800	1,600	100
I D	6,400	0	3,200	6,400	800	3,200	200	1,600	200
V D	3,200	0	400	3,200	800	1,600	800	1,600	200
B C	6,400	100	400	6,400	400	100	800	1,600	1,600

Mount Dessert strains were agglutinated in dilutions of 1 to 100 by the specific Shiga serum, while the reactions of all mannite fermenting strains in the polyvalent serum were high, in most cases reaching the limit of the titer (3200 or 6400). Only one strain did not agglutinate in the polyvalent serum in a dilution above 1 to 100, and its specific (Flexner) serum agglutinated this strain only in the same dilution.

The specific Flexner and Mount Dessert serums agglutinated strains of their homologous types, as a rule, in one to two dilutions beyond that in which the heterologous types also agglutinated.

One strain, though giving the fermentation reaction of the other Mount Dessert strains, failed to agglutinate in the Mount Dessert serum in a dilution beyond 1 to 25, while with the Flexner serum it agglu-

tinated at 1 to 100. This strain, with the more highly specific serums of Murray,[8] agglutinated the V and Y serums in a dilution of 1 to 100. Therefore, its serologic classification was not possible. The important point, however, is that its highest agglutination reaction was obtained with the polyvalent serum used for therapeutic purposes. Its fermentation reactions placed it in the nonmaltose fermenting group of Flexner dysentery bacilli.

No sharp differentiation of the seventeen strains of mannite fermenting dysentery bacilli isolated in the course of this study was obtained with the five Murray serums V, W, X, Y and Z. As the accompanying table shows, seven of the strains agglutinated two or more of the Murray serums equally well, so that their classification into a Murray subgroup was not possible. None of the strains failed to show agglutination with the polyvalent, therapeutic serum used. Therefore, their further serologic classification can only be of academic and not of practical importance, and it is evident that the antidysentery serum made by the New York State Board of Health for therapeutic purposes contained immune bodies corresponding to the antigens of all strains of dysentery bacilli isolated from clinical cases of dysentery occurring during an average New York summer service among young children.

The children's serums were tested for agglutination on admission to the hospital in ten instances, with negative results. Since a dose of antidysentery serum was administered as soon as the infants were admitted to the dysentery ward, this part of the work had to be omitted.

It is interesting that this series of cases studied with improved technic gave a lower percentage of positive dysentery infections (20⅓ per cent.) than did a series at the Babies' Hospital in 1903,[9] when 35 per cent. of positive results were obtained. Davison's [10] high incidence of 83 per cent. of dysentery bacillus infection in cases of acute ileocolitis has never been seen at the Babies' Hospital.

While eight patients died in the present series of twenty cases, twenty-nine died (74 per cent.) in the earlier series of thirty-nine cases. Even when the three unimproved cases are added to the known fatalities, the difference between 55 and 74 per cent. is obvious.

Among the sixty-six cases found negative for dysentery bacilli by bacteriologic examination, thirty-four were clinically diagnosed as dysentery and thirty-two were not. In the latter series the stool examination was made either because diarrhea was a symptom, more or less transient, of a general condition (sepsis, pneumonia, etc.) or because

8. Murray, J. R.: Army M. Corps **31**:257, 1918.
9. Wollstein, Martha: J. M. Research **10**:11, 1903-1904.
10. Davison, W. C.: Bull. Johns Hopkins Hosp. **31**:225 (July) 1920; J. Exper. Med. **32**:651 (Dec.) 1920.

the case was frankly one of intestinal intoxication or noninfectious diarrhea.

In the group of clinical cases of dysentery the mortality rate was 41 per cent. In the noninfectious diarrheas it was 40⅝ per cent. Compared with 40 per cent. mortality for the proved cases of dystentery and 39⅓ per cent. mortality for the entire number of admissions for intestinal disorders, the rate of fatalities is a remarkably even one.

OTHER ORGANISMS

Most interesting were two cases of typhoid fever diagnosed by means of the stool examination. The first case was that of a boy, aged 4 months, who was admitted to the hospital because of diarrhea and vomiting of two weeks' duration. The stools contained no blood, and he was moderately prostrated. Proctoscopic examination demonstrated a mildly congested mucosa but no ulcers. Typhoid bacilli were isolated instead of the expected dysentery bacilli, and then the child's blood was found to give a positive Widal reaction in a dilution of 1 to 100. The boy died of exhaustion after an illness of six weeks, when the typhoid bacilli had disappeared from the stools.

The second child developed diarrhea after he had been in the hospital two weeks, and on the Endo plates inoculated from the specimen of blood-stained mucus obtained by proctoscopic examination many typhoid colonies grew. The child died after an illness of one week, and at necropsy the ileum showed the lymphoid swellings typical of typhoid fever in young children, without ulceration. The bacilli were readily isolated a second time from the intestinal contents obtained at necropsy. While this second typhoid infection undoubtedly occurred in the hospital, its exact source could not be traced. The two children were not on the same floor and they were attended by different nurses. Insufficiently sterilized linen may have been involved.

These two cases emphasized the difficulty encountered in making a diagnosis of typhoid fever in infancy in a nonepidemic period, and demonstrate the similarity of the clinical course of typhoid fever and infectious diarrhea at this age.

An instance of paratyphoid A infection was found in a boy, 2½ months old, admitted as a feeding case with diarrhea of three days' duration. The child recovered, but the bacilli were still present one month after admission. The original source of infection in this instance could not be found. Careful inquiry failed to show any case of illness in the child's immediate surroundings.

A strain of the Morgan group of bacilli was isolated from a child whose illness was diagnosed as dysentery. This bacillus was at first mistaken for *B. dysenteriae*, since its gas production in glucose was very feeble and it did not ferment lactose nor mannite. It was slightly

motile, however, and failed to agglutinate the polyvalent dysentery serum or any of the monovalent serums.

B. faecalis alcaligenes was isolated from the stools of a 6 months old boy whose proctoscopic examination showed much mucus over a congested, bleeding mucosa. The child died, and no dysentery bacilli were found in cultures made from the intestinal mucosa at necropsy. Two strains of nonlactose fermenting intermediate bacilli which do not fit into any group were isolated and reserved for future study.

Finally, *B. pyocyaneus* was found in such large numbers in three instances that the presence of other organisms was obscured. One of these cases, at least, ran a clinical course typical of dysentery, yet two stool cultures on different days failed to show *B. dysenteriae*.

SUMMARY

Bacteriologic examinations of stools from a series of eighty-six young children admitted to the Babies' Hospital with some form of intestinal disturbance were made, and twenty children, or 23½ per cent., were found to harbor dysentery bacilli.

Among the twenty positive dysentery cases, there were three of the Shiga type of *B. dysenteriae*, five of the Flexner type and twelve of the Mount Dessert type.

The highest mortality rate occurred among the group of Shiga infections; but the group of Mount Dessert infections showed the most prolonged course and the severest lesions at necropsy.

The mortality rate of the dysentery group of cases was 40 per cent., while the mortality of the entire group was 39½ per cent.

Serum therapy was applied in seventeen of the twenty children suffering from dysentery, with no untoward, and no strikingly positive, results.

Two cases of typhoid and one of paratyphoid infection were discovered in the course of the study.

A STATISTICAL ANALYSIS OF THE CAUSES OF PALPABLE LYMPH GLANDS IN THE NEW-BORN *

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The variation in the number of discernible lymph nodes in the new-born has given rise to divergent views concerning the normal occurrence. The epidermis and subcutaneous tissue of an infant are so thin and soft that a nerve or artery, a bony protuberance or tendon can readily be misinterpreted as an enlarged gland. External factors, such as coryza, infection and fever, influence the relatively unstable system of the new-born and bring about enlarged lymph nodes. Prenatal factors, such as syphilis, must also be considered. The purpose of this study is to analyze, in a carefully controlled group of cases, some of the manifold causes which give rise to the palpable glands of the new-born. We are grateful to the Asbury Hospital, Minneapolis, for cooperation in the collection of material, and we are also indebted to Drs. R. E. Scammon and W. P. Larson for their valuable suggestions.

The results of previous work done upon this subject are somewhat antagonistic. Jensen [1] published a work upon palpation of the occipital and cervical glands of the new-born during the first nine days of life. He comes to the conclusion, after a study of 240 babies, that no pathologic significance can be attached to the frequent discovery of palpable lymph nodes and that the explanation of this condition on the basis of an infection is illogical. Coerper,[2] after a study of 100 new-born infants, concluded that the swelling of the glands must be due entirely to either an infection or a physiologic activity of the lymph system. Baer [3] agrees with Coerper that the palpability of peripheral glands in the new-born signifies nothing pathologic and presupposes, therefore, no preceding sickness. He also arrives at the sensible conclusion that it is extremely difficult to distinguish between normal glands which are just palpable and moderately pathologic enlargements. He advances this explanation as a reason for the variation in the results of different

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* Contribution from Asbury Hospital, Minneapolis, and Department of Anatomy, University of Minnesota.

1. Jensen, T.: Hintere Hals- und Nackendrüsen bei Säuglingen in den ersten neun Lebenstagen, Ztschr. f. Kinderh. **14**:176 (March 28) 1916.

2. Coerper, C.: Ueber die Palpation peripherer Drüsen und deren klinische Bedeutung bei Kindern der ersten zwei Lebensjahre, Monatschr. f. Kinderh. **13**:458 (Oct.) 1915.

3. Baer, A.: Zur Schwellung der peripheren Lymphdrüsen im Säuglingsalter, Jahrb. f. Kinderh. **56**:814, 1902.

investigators. Reiche,[4] and Grosser and Dessauer [5] find that a large percentage of cubital glands of infants showing signs of congenital syphilis are palpable. Gundobin,[6] in a study of fifty new-born infants, finds no palpable glands in half of his cases, while in the other half the cervical and inguinal glands appear most frequently. Stahr,[7] Dietrich,[8] Vierordt,[9] Hochsinger [10] and Hess [11] offer data bearing on the subject to a less extent. The results of these authors will be considered later in the discussion.

METHODS AND MATERIAL

The conditions for procuring the data were advantageous. The material was collected during the months of November, December and January (1920 and 1921). Considering the fact that respiratory infections start during the early winter in Minneapolis, it is surprising that more nose and throat infections did not occur. Only one case of coryza was noted in the entire series of 102 cases, and this baby was isolated until the rise in temperature and symptoms had abated. The work was carried out in the babies' ward of the Asbury Hospital. The room was kept at an average temperature of about 80 F., and extreme care was observed in aseptic handling of the babies. The infants were palpated in the morning between 8 and 9 o'clock, and the observations were made every two days. The new-born infants were palpated as soon as possible after birth, usually within the first two hours. Since it was not practical to examine the infants every day, some of the data were obtained on the first, third, fifth, seventh, ninth, eleventh and thirteenth days after birth, and the remaining were secured on the first, second, fourth, sixth, eight, tenth and twelfth days.

The babies were weighed between 8 and 10 a. m., and their rectal temperatures taken and recorded at this time. The senior investigator did the palpation for the entire series in order to eliminate differences

4. Reiche, A.: Ueber den diagnostischen Wert tastbarer Cubitaldrüsen bei Säuglingen, Monatschr. f. Kinderh. **6**:511 (Oct.) 1908; abstr. Jahrb. f. Kinderh. **68**:494, 1908.

5. Grosser, P., and Dessauer, A.: Ueber die diagnostische Bedeutung fühlbarer Kubitaldrüsen bei Kindern, München. med. Wchnschr. **58**:1130 (May 23) 1911.

6. Gundobin, A. P.: Die Besonderheiten des Kindesalters, Berlin, 1912, p. 161.

7. Stahr, H.: Die Zahl und Lage der submaxillaren und submentalen Lymphdrüsen vom topographischen und allgemein anatomischen Standpunkte, Arch. f. Anat. u. Physiol., December, 1898, p. 444.

8. Dietrich: Die Palpation der Lymphdrüsen, Sitzungsb. d. phys.-med. Soc. zu Erlang. **18**:52 (July) 1886.

9. Vierordt, H.: Daten und Tabellen für Mediziner, Ed. 3, Jena, 1906.

10. Hochsinger, C.: Ueber tastbare Cubital- und Seitliche Thoraxlymphdrüsen im Säuglingsalter, Wien. med. Wchnschr. **57**:2114 (Oct.) 1907.

11. Hess, A. F.: Enlargement of the Epitrochlear and Other Lymph Nodes in Infants, Arch. Pediat. **24**:602 (July) 1907.

in judgment. The baby to be examined was unclothed and placed on a table with its head toward the observer. The investigator palpated all lymph glands in two directions, at right angles to each other. First he felt for the mental and cervical glands. After identifying the presence of the cervical glands, deeper pressure was made in a search for the transverse process of the atlas, which can be mistaken for a lymph node in a malnourished infant. Passing the finger still farther posteriorly, the posterior auricular and occipital nodes were sought for in turn. The axillaries were more difficult to examine. To accomplish this the observer grasped the right arm of the baby with his right hand and palpated the right axilla with the middle finger of his left hand. In order to distinguish between an enlarged lymph node and the head of the humerus, he rotated the arm of the infant and outlined the articular surface of the head of the humerus as it glided beneath his finger. The investigator next palpated the epitrochlear and inguinal nodes. In a majority of cases the inguinal nodes were visible as well as palpable, especially if the legs of the infant were extended and slightly separated.

The babies examined numbered 102; fifty-two boys and fifty girls. The series represents 102 consecutive deliveries from 1,100 babies born within a period of twelve months in the maternity department of Asbury Hospital. All the infants were Caucasian. One baby died on the first day as a result of birth trauma and instrumental delivery; another was taken out of the hospital on the second day; all the others stayed at least six days. Eleven went home on the seventh day; thirty-one more left on the ninth day, and only eight babies remained in the hospital after the thirteenth day. Any factor which might influence the number of palpable lymph glands was carefully noted. One child had a cold and temperature of 104 F. on the second day; ten were jaundiced; six had infected eyes; eighteen were circumcised; two had vaginal discharge, which, in one instance, proved to be gonorrheal in origin; twenty-five ran a temperature of more than 100 F. at some time during their sojurn in the hospital; four had infected or moist cord stumps; one showed rectal bleeding; and fifteen were premature infants, weighing between 4 and 5 pounds. The mouth, nose and pharynx were examined for discharge but not for redness of the mucous membrane or slight signs of infection.

The data collected as described above are qualitative and not quantitative. The glands were classified into three types: just discernible, distinctly palpable and swollen. The accuracy of such qualitative data, depending largely upon the judgment and sense of touch of the investigator, can, of course, be questioned since they cannot have the mathematical precision of quantitative measurements. Everything possible was done to eliminate the personal equation. The technic was exactly the same in all cases. The investigator used the same finger to palpate

similar nodes and held the babies in identical positions. He knew nothing previous to the completion of the collection of data concerning the results of Coerper, Baer and Jensen in order that their conclusions might not warp his judgment.

While the accuracy of the data depends entirely upon the individual judgment and the care observed in their collection, their significance can only be determined by a qualitative statistical study. In this instance the material was reduced to a percentage basis. By means of this an accurate estimate of results was obtained. Tables were constructed of the accessory factors which might influence the enlargement of lymph glands. Others were made to give detailed data concerning the inguinal, occipital and cervical glands. None were made, however, for the axillary, cubital or mental glands, since these nodes were not palpable in any instance in the entire series. They will be considered in the discussion only.

TABLE 1.—AVERAGE TEMPERATURE AND WEIGHT

Time in Days	No. of Cases	Average Temperature, Degrees	No. of Cases	Average Weight, Pounds
1	72	98.33	99	7.306
2	29	99.06	25	6.956
3	69	98.94	66	6.945
4	24	99.07	17	6.672
5	72	98.35	72	6.993
6	26	98.08	26	6.861
7	57	98.22	56	7.071
8	16	98.36	14	7.021
9	41	98.33	42	7.093
10	12	98.12	10	6.937
11	22	98.17	19	7.181
12	2	97.30	2	7.470
13	6	98.17	6	7.542

CONSIDERATION OF TABLES

The average temperatures and weights of the babies are shown in Table 1. This table affords a check on the normality of the new-born infants under observation. The temperature taken by rectum ranged between 98 and 99 F. In only one group was the average temperature above 99 F. and this one represented twenty-four babies, three of whom had a temperature of more than 101 F. According to the normal figures of Vierordt [9] the average temperature is 100 F. at birth and 99.5 F. during the first week of postnatal life. The temperatures of these new-born infants were lower than normal, owing perhaps to the fact that birth temperatures were taken from about fifteen to twenty minutes after birth, and reflect, therefore, the heat loss resulting from the exposure of the baby. The infants were covered very lightly with only one blanket during their sojourn in the hospital which probably accounts for the slightly subnormal body temperatures.

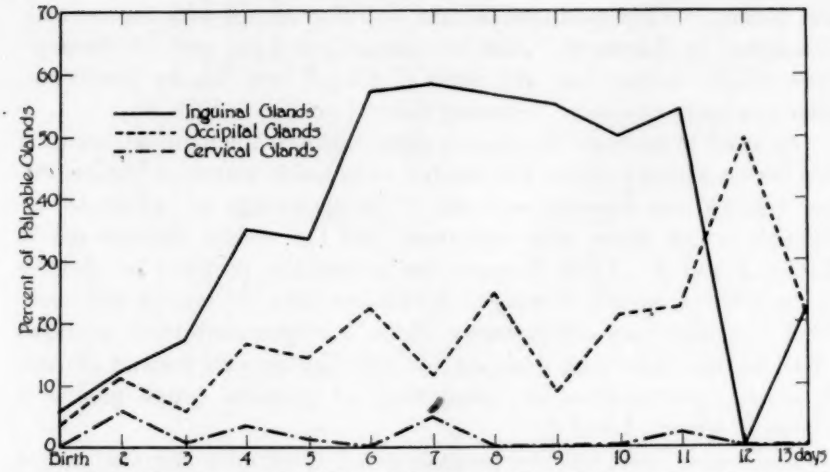

Chart 1.—Degree of palpability of the inguinal, occipital and cervical lymph nodes for each day.

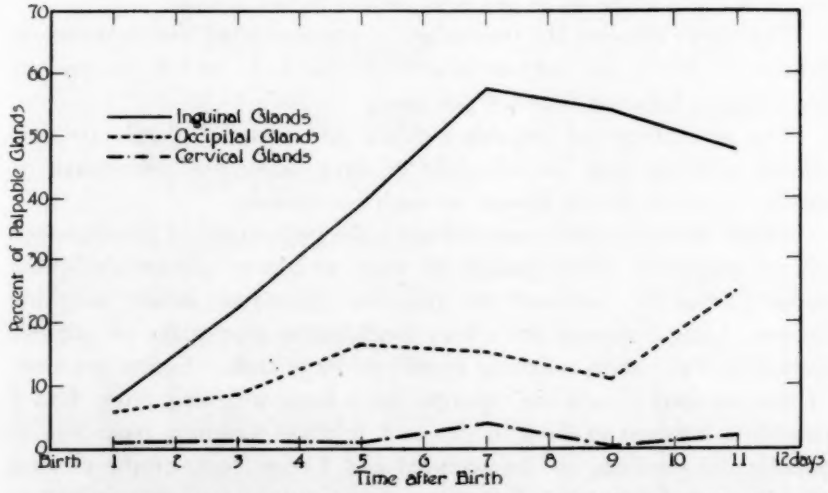

Chart 2.—Degree of palpability of the inguinal, occipital and cervical lymph nodes grouped for each two days.

The average birth weight (Table 1) was 7.3 pounds, which agrees approximately with the average new-born weights given by Emerson and Manny.[12] The postnatal weight loss also agrees with the normal, established by Hammett;[13] this loss amounts to 5 per cent. of the new-born weight on the third day, sinks to 8.6 per cent. on the fourth and then gradually recovers, becoming normal on the twelfth day.

In order to estimate the relative significance of the inguinal, occipital and cervical lymph nodes, the number of palpable glands in the respective regions was counted each day. The percentage of occurrence of palpable lymph nodes was calculated, and the results summarized in Tables 2 and 3. Table 2 shows the percentage presence or absence of these lymph nodes. Owing to insufficient data, the results are somewhat irregular, and consequently Table 3 is prepared from averages based on the same data grouped for two day periods instead of one. A graphic portrayal of the percentage of palpable lymph glands is shown in Charts 1 and 2.

The curve showing the percentage of discernible inguinal nodes (Chart 2) rises steadily from about 8 per cent. on the first day to a height of approximately 58 per cent. on the seventh day and then steadily and gradually falls to 48 per cent. on the eleventh day.

The curve based upon the palpable occipital glands ascends from 6 per cent. on the first day of life to about 16 per cent. on the fifth day, then descends slightly to 11 per cent. on the ninth day, and finally makes a sharp climb to 25 per cent. on the eleventh day.

The curve showing the percentage of cervical involvement shows no definite tendency, the number of cervical glands to be felt on any one day ranging between 0 and 4 per cent.

The percentages of palpable inguinal and occipital glands are correlated with the age of the child in days, while the percentage of swollen cervical glands shows no such correlation.

Other factors besides time influence the percentage of glands which can be palpated. The relation of body weight to discernible lymph nodes (Table 4) demonstrates that the premature infant weighing between 4 and 5 pounds has a very much higher percentage of palpable glands than the child weighing from 5 to 10 pounds. Eighty per cent. of the inguinal glands are enlarged in infants weighing from 4 to 5 pounds in contrast to about 31 per cent. in those weighing from 5 to 10 pounds; 53 per cent. of the occipital and 13 per cent. of the cervical glands in the premature infant are increased in size in contrast to approximately 11 per cent. and 1 per cent., respectively, in the heavier

12. Emerson, W. R. P., and Manny, F. A.: Weight and Height in Relation to Malnutrition, Arch. Pediat. **37**:468 (Aug.) 1920.

13. Hammett, F. S.: The Relation Between Growth Capacity and Weight at Birth, Am. J. Physiol. **45**:396 (March) 1918.

TABLE 2.—Percentage Presence and Absence of Lymph Glands

Time in Days	No. of Cases	Nonpalpable Lymph Nodes									Palpable Lymph Nodes								
		Inguinal			Occipital			Cervical			Inguinal			Occipital			Cervical		
		Right	Left	Both	Right	Left	Both	Right	Left	Both	Right	Left	Both	Right	Left	Both	Right	Left	Both
1	102	93.1	95.1	94.1	94.1	98.0	96.1	100.0	100.0	100.0	6.9	4.9	5.9	5.9	2.0	3.9	0.0	0.0	0.0
2	35	85.7	88.6	87.2	85.7	91.4	88.6	94.3	97.1	95.7	14.3	11.4	12.8	14.3	8.6	11.4	5.7	2.9	4.3
3	72	82.0	83.3	82.7	93.0	95.8	94.4	99.6	100.0	99.8	18.0	16.7	17.3	7.0	4.2	5.6	1.4	0.0	0.7
4	27	59.3	70.4	64.9	81.5	85.2	83.4	96.3	96.3	96.3	40.7	29.6	35.1	18.5	14.8	16.6	3.7	3.7	3.7
5	73	64.3	68.5	66.4	83.6	86.0	84.3	97.3	100.0	98.7	35.7	31.5	33.6	16.4	12.3	14.3	2.7	0.0	1.3
6	27	44.4	40.7	42.6	77.8	77.8	77.8	100.0	100.0	100.0	55.6	59.3	57.4	22.2	22.2	22.2	0.0	0.0	0.0
7	67	37.3	46.3	41.8	86.6	89.6	88.1	94.0	95.5	94.8	62.7	53.7	58.2	13.4	10.4	11.9	6.0	4.5	5.2
8	22	40.8	45.5	43.2	72.7	77.4	75.1	100.0	100.0	100.0	59.2	54.5	56.8	27.3	22.7	25.0	0.0	0.0	0.0
9	47	40.4	49.0	44.7	91.5	91.5	91.5	100.0	100.0	100.0	59.6	51.0	55.3	8.5	8.5	8.5	0.0	0.0	0.0
10	12	50.0	50.0	50.0	75.0	83.4	79.2	100.0	100.0	100.0	50.0	50.0	50.0	25.0	16.6	20.8	0.0	0.0	0.0
11	23	43.5	47.9	45.7	82.6	73.9	78.3	95.6	100.0	97.8	56.5	52.1	54.3	17.4	26.1	21.7	4.4	0.0	2.2
12	3	100.0	100.0	100.0	33.3	66.7	50.0	100.0	100.0	100.0	0.0	0.0	0.0	66.7	33.3	50.0	0.0	0.0	0.0
13	7	71.5	85.7	78.6	85.7	71.4	78.6	100.0	100.0	100.0	28.5	14.3	21.4	14.3	28.6	21.4	0.0	0.0	0.0

TABLE 3.—Percentage Presence and Absence of Lymph Glands (Grouped)

Time in Days	No. of Cases	Nonpalpable Lymph Nodes									Palpable Lymph Nodes								
		Inguinal			Occipital			Cervical			Inguinal			Occipital			Cervical		
		Right	Left	Both	Right	Left	Both	Right	Left	Both	Right	Left	Both	Right	Left	Both	Right	Left	Both
1- 2	137	91.2	93.4	92.3	91.9	96.3	94.1	98.5	99.3	98.9	8.8	6.6	7.7	8.1	3.7	5.9	1.5	0.7	1.1
3- 4	99	75.8	79.8	77.8	89.9	92.9	91.4	98.0	99.0	98.5	24.2	20.2	22.2	10.1	7.1	8.6	2.0	1.0	1.5
5- 6	100	58.9	62.0	60.5	82.0	85.0	83.5	98.0	100.0	99.0	41.1	38.0	39.5	18.0	15.0	16.5	2.0	0.0	1.0
7- 8	89	38.2	46.1	42.1	83.2	86.6	84.9	95.5	96.6	96.0	61.8	53.9	57.9	16.8	13.4	15.1	4.5	3.4	3.4
9-10	59	42.3	49.2	45.7	88.2	89.8	89.0	100.0	100.0	100.0	57.7	50.8	54.3	11.8	10.2	11.0	0.0	0.0	0.0
11-12	26	50.1	54.1	52.1	76.9	73.1	75.0	96.1	100.0	98.1	49.9	45.9	47.9	23.1	26.9	25.0	3.9	0.0	1.9

TABLE 4.—Relation of Body Weight to Body Temperature and to Palpable Lymph Glands

Body Weight, Pounds		No. of Cases	Average Body Temperature, F.	Palpable Lymph Glands											
				Inguinal				Occipital				Cervical			
				Right Absolute	Left Absolute	Average		Right Absolute	Left Absolute	Average		Right Absolute	Left Absolute	Average	
Range	Average					Absolute	Per Cent.			Absolute	Per Cent.			Absolute	Per Cent.
4– 5	4.471	15	98.0	13	11	12.0	80.0	8	8	8.0	53.3	2	2	2.0	13.3
5– 6	5.672	36	98.7	12	9	10.5	29.2	7	5	6.0	16.7	0	0	0.0	0.0
6– 7	6.492	151	98.4	58	51	54.5	36.0	18	14	16.0	10.4	5	1	3.0	2.0
7– 8	7.381	178	98.6	48	48	48.0	26.9	14	8	11.0	6.2	2	1	1.5	0.8
8– 9	8.317	59	98.5	21	17	19.0	32.2	8	5	6.5	11.0	1	0	0.5	0.8
9–10	9.250	13	98.0	3	2	2.5	19.2	2	2	2.0	15.3	0	0	0.0	0.0

TABLE 5.—Relation of Body Temperature to Palpable Lymph Glands

Body Temperature, F.		No. of Cases	Palpable Lymph Glands											
			Inguinal				Occipital				Cervical			
			Right Absolute	Left Absolute	Average		Right Absolute	Left Absolute	Average		Right Absolute	Left Absolute	Average	
Range	Average				Absolute	Per Cent.			Absolute	Per Cent.			Absolute	Per Cent.
97– 98	97.4	85	32	30	31.0	36.4	14	9	11.5	13.5	0	0	0	0.0
98– 99	98.7	256	102	81	91.5	35.7	33	25	29.0	11.3	9	5	7	2.7
99–100	99.2	78	18	18	18.0	23.1	5	4	4.5	5.8	2	0	1	1.3
100–101	100.3	14	3	3	3.0	21.4	0	0	0.0	0.0	0	0	0	0.0
101–102	101.1	3	0	0	0.0	0.0	1	1	1.0	33.3	0	0	0	0.0
102–103	102.1	3	1	1	1.0	33.3	1	1	1.0	33.3	0	0	0	0.0
103–104	103.3	5	1	1	1.0	20.0	1	0	0.5	10.0	0	0	0	0.0
104–105	104.0	1	1	0	0.5	50.0	1	1	1.0	100.0	1	1	1	100.0

new-born infants. If the percentage of the occipital, cervical and inguinal nodes is averaged (Chart 3), it is seen that 49 per cent. of all glands of the premature infant are palpable. Prematurity, therefore, increases the number of lymph glands which can be palpated in the new-born.

In order to determine whether body temperature is a factor in bringing about an increase in the percentage of palpable lymph glands, the percentage of discernible inguinal, occipital and cervical nodes was determined for each degree of temperature, Fahrenheit (Table 5). With the exception of one infant with a temperature of from 104 to 105 F., who showed a generalized lymphadenopathy, those infants with

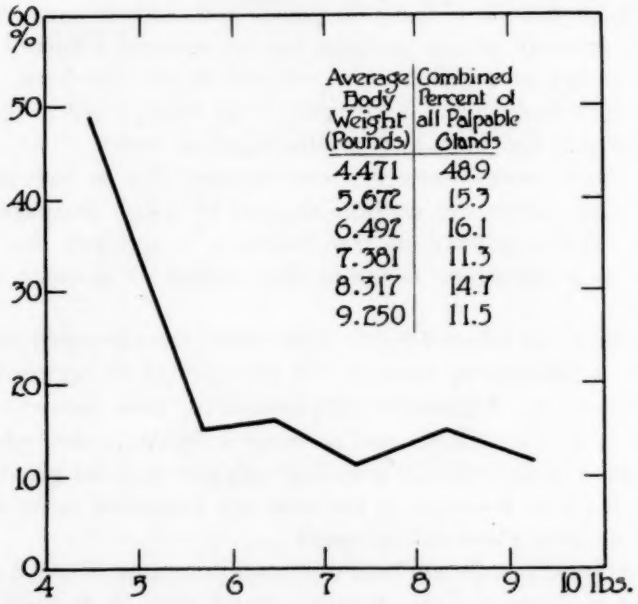

Chart 3.—Relation of palpability of inguinal, occipital and cervical lymph nodes to body weight.

a normal temperature between 97 and 99 F. showed the highest percentage of lymph node involvement. A temperature of more than 100 F. in the new-born infant, therefore, does not necessarily mean infection with subsequent lymph node enlargement. On the contrary, some other factor than infection must play an important part in the enlargement of the lymph glands.

Other factors which can account for the presence or absence of palpable nodes are considered in Table 6. Sex is the first to be eliminated. There is no difference between male and female. The percentage of inguinal glands enlarged in the male was 72 against 68 in

the female, the average involvement being 70. Considering the comparatively few cases involved, no significance can be attached to a 2 per cent. variation above and below the average. The percentage of occipital and cervical glands does not show even minor differences between male and female.

Circumcision was performed on eighteen of the fifty-two boys. The foreskin was consequently somewhat swollen, and it was thought that the operation might account for a small percentage of the inguinal gland enlargement. Consequently, the circumcised boys were separated from the uncircumcised, and it was found that 70 per cent. of the circumcised and 74 per cent. of the uncircumcised (Table 6) showed discernible inguinal glands. This signifies that circumcision plays no part in the production of palpable glands and tends to prove that the lymphatic drainage of the genitalia has no material influence on the high percentage of inguinal nodes noticed in the new-born. To be sure, two girls had vaginal discharges, in one case proved to be gonorrheal in origin, and both had swollen inguinal nodes. The occipital glands of these babies, however, were enlarged also in both instances although they could play no possible part in lymph drainage of the genitalia. The cases were too few, therefore, to conclude that vaginal discharge is a significant factor in the etiology of palpable inguinal nodes.

Six babies had infected eyes. These cases were grouped and show apparently a relationship between the enlargement of occipital glands and eye infections. Eighty-three per cent. of the cases showed a distinct enlargement of the occipital and posterior auricular nodes, while only 21 per cent. without infected eyes had palpable occipital glands. The cases are too few, however, to correlate eye infections as an etiologic factor of occipital gland enlargements.

Temperature has already been discussed as a cause of nodal enlargement, and a glance at Table 6 shows that it plays a decidedly minor rôle. If one considers every temperature of more than 100 F. as abnormal and under 100 F. as normal, normal temperature of the new-born in the first week of life being approximately 99.5 F. according to Vierordt,[9] then rise of temperature shows only a slight correlation to increased lymph node involvement. In the case of inguinal glands, 76 per cent. are enlarged with high temperature and only 68 per cent. with normal. The occipital glands show no difference between high and low temperatures. The cervical glands show a decided variation, 12 per cent. being palpable with high temperatures and only 4 per cent. with normal. This correlation between high temperatures and enlarged cervical glands is probably brought about by mouth and pharyngeal infections which are accompanied by fever. Unfortunately,

TABLE 6.—Causative Factors of Lymphadenopathy

Factors Associated with Lymphadenopathy	No. of Cases	Palpable Inguinal Nodes					Palpable Occipital Nodes					Palpable Cervical Nodes					Axillary Nodes, No.	Epitrochlear Nodes, No.	Mental Nodes, No.
		Right, No.	Left, No.	Both, No.	Average		Right, No.	Left, No.	Both, No.	Average		Right, No.	Left, No.	Both, No.	Average				
					No.	%				No.	%				No.	%			
Males	52	37	38	36	37.5	72	13	13	11	13.0	25.0	4	2	2	3.0	6	0	0	0
Females	50	35	33	32	34.0	68	14	10	10	12.0	24.0	4	2	2	3.0	6	0	0	0
Male and female	102	72	71	68	71.5	70	27	23	21	25.0	24.5	8	4	4	6.0	6	0	0	0
Circumcised	18	13	12	12	12.5	70	8	6	6	7.0	39.0	3	1	1	2.0	11	0	0	0
Uncircumcised	34	24	26	24	25.0	74	5	7	5	6.0	18.0	1	1	1	1.0	3	0	0	0
Cases with vaginal discharge	2	2	2	2	2.0	100	2	2	2	2.0	100.0	0	0	0	0.0	0	0	0	0
Infected eyes	6	5	4	4	4.5	75	6	4	4	5.0	83.0	1	0	0	0.5	8	0	0	0
Uninfected eyes	96	67	67	64	67.0	70	21	19	17	20.0	21.0	7	4	4	5.5	6	0	0	0
Temperature over 100 F. at some time	25	20	18	18	19.0	76	7	5	5	6.0	24.0	4	2	2	3.0	12	0	0	0
Temperature under 100 F. at all times	77	52	53	50	52.5	68	20	18	16	19.0	25.0	4	2	2	3.0	4	0	0	0
With jaundice	10	8	8	8	8.0	80	4	5	3	4.5	45.0	0	0	0	0.0	0	0	0	0
With moist cord stumps	4	2	2	2	2.0	50	1	1	1	1.0	25.0	0	0	0	0.0	0	0	0	0
Rectal bleeding	1	1	1	1	1.0	100	0	0	0	0.0	0.0	1	1	1	1.0	100	0	0	0
With any of the foregoing factors	52	41	39	39	40.0	77	16	14	12	15.0	29.0	6	3	3	4.5	9	0	0	0
With none of the foregoing factors	50	31	32	29	31.5	63	11	9	9	10.0	20.0	2	1	1	1.5	3	0	0	0

all cases of mouth and pharyngeal infections were not discovered, since only purulent discharges from the nose and mouth were recorded.

Icterus neonatorum is also a factor in lymphadenopathy. There were ten cases of jaundice in the 102 babies examined. Eighty per cent. of the jaundiced babies had palpable inguinal nodes, and 45 per cent. had discernible occipital glands. The number of cases is too small to conclude that icterus is a cause of lymph node enlargement.

Another possible factor which might cause enlargement of the inguinal lymph glands is a moist or an infected cord stump. Consequently, the cords were inspected at each palpation. Only four of the 102 babies showed a moist cord stump at some time, and of these four, 50 per cent. had enlarged inguinal glands. If bacterial invasion of the moist cord stumps had taken place, the inguinal lymph nodes which drain the umbilical region would undoubtedly be swollen. The dry cord stumps, however, apparently have a higher correlation with the swollen inguinal glands than do the moist umbilical stumps.

A close inspection of Table 6 shows an apparent difference between the number of glands on the right and left sides of the body. The nodes on the right side of the body apparently predominate over those of the left. The importance of this fact is questionable. The differences are too small and the number of cases are too few to establish the truth beyond question. No significance is attached, therefore, to the apparent difference between the right and left sides.

All the factors, with the exception of an infected throat, which might bring about lymphadenopathy have been considered. The surprising result is that these important factors influence slightly the production of lymph gland enlargement in the new-born. The average inguinal node involvement of male and female (Table 6) is 70 per cent., that of the occipital glands 24.5 per cent. and of the cervical glands 6 per cent. If all cases which are influenced by any accessory factor, such as sex, circumcision, infected eyes, fever and jaundice, are grouped as a unit, 77 per cent. of the inguinal nodes, 29 per cent. of the occipital nodes and 9 per cent. of the cervical nodes are palpable. If all the cases in which none of these factors exist are classed together, only 63 per cent. of the inguinal glands, 20 per cent. of the occipital glands and 3 per cent. of the cervical glands can be felt. This means that the factors mentioned above account for approximately one tenth of the inguinal gland enlargement, one fifth of the occipital nodes and one half of the cervical swellings. It is highly probable that if a close inspection for slight infections of the nasal and pharyngeal cavities had been undertaken all of the palpable cervical glands could be accounted for by known factors. The importance of this detail was not appreciated, however, at the time the data were accumulated.

CAUSES OF LYMPHADENOPATHY

The elimination of external factors which might cause lymph gland enlargement brings us to a consideration of other causes which might produce lymphadenopathy.

Enlarged cervical lymph nodes result from mouth, nasal and pharyngeal infections. This conclusion is supported by Jensen.[1] In a series of 240 new-born infants (Table 7) he found that 10 per cent. showed cervical gland enlargement the first day after birth, 6.6 per cent. on the second day, and the percentage of enlargement steadily diminished to 0.8 per cent. on the seventh day of postnatal life. He believed that mouth and nose infections, usually mild in character, were responsible for these cervical gland enlargements. Coerper[2] agrees with this point of view. He palpated 100 new-born infants (Table 7) and found 34 per cent. of the cervical glands. He believes that infection occurs most frequently in the nasal pharynx, associated with slight catarrh of the first part of the air passages and that the cervical nodes appear with

TABLE 7.—RESULTS OF VARIOUS AUTHORS IN PALPATION OF THE LYMPH GLANDS OF THE NEW-BORN

		Axillary Nodes		Occipital Nodes		Cervical Nodes		Inguinal Nodes		Cubital Nodes	
Author	No. of Cases	Absolute	Per Cent.	Absolute	Per Cent.	Absolute	Per Cent.	Absolute	Per Cent.	Absolute	Per Cent.
Coerper.....	100	95	95	14	14.0	34	34	17.0	17	2	2
Jensen.....	240	..	..	104	43.3	24	10	....	..	..	..
Baer.....	25	majority		few	....	few	..	few	..	..	..
Gundoblin..	50	1	2	...	....	..	(Ca) 17	....	(Ca) 17	..	..
Dunn.....	102	0	0	25	24.5	6	6	71.5	70	0	0

the first sign of infection. The time of year and the amount of coryza may account for the high percentage of palpable cervical glands found in his series.

In respect to the axillary glands there is a wide variation of opinion. Of the 102 babies examined in our series not one axillary gland was palpable. Coerper, however, finds 95 per cent. of the axillary glands present. The five babies which had no discernible axillary nodes were all premature babies of 7 months. He states that the cause for the axillary gland swelling must lie in a process of the tributary field of this gland. But mastitis was found in only two cases and, consequently, the only cause he could assign for the remaining 93 per cent. was the physiologic breast gland swelling of the new-born. Baer[3] also noted the constancy of the axillary node swellings. He palpated the glands of twenty-five new-born infants ranging in age from 10 hours to 5 days and found that the axillary nodes were not only more constant but considerably smaller, while the occipital, cervical and inguinal glands occurred only in isolated cases. Hochsinger[10] and Gundobin[6] believed that Baer palpated small fat lobules in the axilla which he thought to be

millet-sized axillary glands. It is our impression also that both Baer and Coerper were deceived as to the presence of lymph glands. The head of the humerus and large nerve trunks as well as fat lobules can readily be mistaken for the axillary nodes. In palpation of these glands in our series the investigator rotated the arm of the baby with one hand while with the fingers of the opposite he searched the axilla. By this means the head of the humerus could be felt gliding beneath the fingers, apparently increasing in size as a larger portion of the articular surface became subcutaneous. The nerve trunks could be differentiated from lymph nodes by palpating in two directions, across them and longitudinally.

Mental lymph nodes were not palpable in a single case in our series and none of the other investigators have made note of them.

Although epitrochlear glands were not found in a single instance in our experiment, several investigators have pointed out their occurrence. Grosser and Dessauer,[5] in a study of 1,066 infants, show that 66 per cent. of congenital syphilitic babies (fifteen in number), 19 per cent. of the rachitic infants (twenty in number) and 4.6 per cent. of the normal children had palpable epitrochlear glands. Hess [11] and Reiche [4] emphasized the value of the epitrochlears as an aid to the diagnosis of congenital syphilis. All three investigators grouped the new-born infants with infants of the first year. In the new-born infant, therefore, the significance of palpable epitrochlear lymph nodes is doubtful.

The occipital and inguinal nodes are still to be considered. The accountable factors which could influence the enlargement of the occipital lymph nodes are infected eyes and jaundice. We know by a consideration of Table 6 that of all the palpable occipital glands approximately 4.5 per cent. are caused by two factors, jaundice and eye infections. Patients with jaundice have 45 per cent. of palpable occipital nodes in contrast to a normal of 24.5 per cent. The six babies with eye infections show 83 per cent. of occipital enlargements. A certain percentage of occipital gland involvement might be accounted for by invasion of the tonsillar crypts by bacteria. Davis [14] and Goslar [15] have shown that bacterial flora invade the tonsils from twenty-four to seventy-two hours after birth and that plasma cells appear in the tonsillar crypts in about two weeks. The sudden increase of enlarged occipital glands from 11 per cent. on the tenth day to 25 per cent. on the thirteenth day is probably a result of tonsillar infection. The accessory factors, jaundice, vaginal discharge and high temperature,

14. Davis, D. J.: On Plasma Cells in the Tonsil, J. Infect. Dis. **10**:142 (March) 1912.

15. Goslar, A.: Das Verhalten der lymphocytären Zellen in den Gaumenmandeln vor und nach der Geburt, Beitr. z. path. Anat. u. allg. Path. **56**:405, 1913.

account for only 7 per cent. of swollen inguinal glands. The largest portion of occipital and inguinal lymph node involvement occurs as a result of some factor not considered heretofore. Some substance coming from the area drained by these glands must be responsible.

What can this factor be? There seem to be four possible causes of inguinal lymph gland enlargement: (1) infection, (2) the sensitization of the new-born infant against the placental foreign tissue as suggested by Abderhalden, (3) a toxic material which might arise from the cord stump, and (4) absorption of a sterile foreign protein by the umbilical lymphatics.

1. Infection is the most common cause of lymphadenopathy. The cardinal signs of local infection are redness, heat, swelling and pain. None are present in the area about the dried stump of the cord. Infection, if severe, usually results in fever, but, as previously shown, the incidence of fever has no correlation with the enlargement of the inguinal nodes. Acute focal infection also gives rise to a leukocytosis in a large majority of cases. In order to see whether the enlargement of the inguinal lymph glands might be correlated with polymorphonuclear leukocytosis, blood counts were taken on fifteen infants about 5 days of age. This work was done by Lippman [16] in connection with a study of the blood of the new-born. Thirteen of the babies had palpable inguinal glands. The normal leukocyte count established by Lippman was 8,000 at birth, about 13,500 at 12 hours, and 3,000 by the fifth day of postnatal life. In all cases the blood count of those infants having palpable inguinal glands agreed with the normal. The curve of inguinal node involvement which rises steadily until the seventh day (Chart 2) is not correlated in any way with the change in the leukocyte count. All cardinal symptoms of infection are lacking in the normal infant, from 5 to 7 days of age, as well as a temperature and leukocytic reaction. Infection is ruled out, therefore, as a possible cause of inguinal lymph gland enlargement.

2. The sensitization of the new-born against the cord proteins is a possible cause of inguinal lymphadenopathy. Abderhalden [17] believed that foreign proteins stimulate the formation of protective substances which are capable of hydrolyzing this protein. These immunizing antibodies are specific and will react only against the inciting substances. If umbilical cord, therefore, is considered to be an antigen, just as Abderhalden believed placental tissue to be foreign protein, antibodies should be developed in the new-born infant against the cord proteins.

To prove the presence or absence of such antibodies, a fresh piece of umbilical cord was secured under sterile conditions. It was ground

16. Lippman, H. S.: Unpublished thesis.

17. Abderhalden, E.: Weiter Beitrag zur biologischen Feststellung der Schwangerschaft, Ztschr. f. physiol. Chem. **81**:90 (Oct.) 1912.

to very fine pulp and let stand for a week in physiologic sodium chlorid solution containing 0.25 per cent. of tricresol. The extraction was then titrated for one-tenth and one-fifth dilution against sheep's red blood cells and the one-fifth dilution found to be a satisfactory antigen. Samples of blood were taken from five babies (Table 8). They ranged from 3 to 13 days in age and all but one showed palpable inguinal glands. The blood samples were subjected to complement fixation tests which were carried out in a manner similar to that employed in a Wassermann test, except for the use of umbilical cord antigen. In all cases the tests were negative. The enlargement of the inguinal glands,

TABLE 8.—COMPLEMENT FIXATION BLOOD REACTIONS AND SKIN ANAPHYLACTIC TESTS

Part A.—Fresh Umbilical Cord Used as an Antigen

Case No.	Sex*	Age, Days	Weight, Gm. At Birth	Weight, Gm. Present	Temperature	Cord Presence	Palpable Glands: Inguinal Right	Palpable Glands: Inguinal Left	Palpable Glands: Axillary, Occipital, Cervical Right	Palpable Glands: Axillary, Occipital, Cervical Left	Blood Reaction
103	♀	3	3,170	2,920	98.4	+	+	—	—	—	—
104	♂	6	4,310	4,260	98.4	+	—	—	—	—	—
105	♀	8	3,025	2,950	98.4	—	+	—	—	—	—
106	♂	8	3,330	3,000	98.2	—	+	—	—	—	—
107	♂	13	3,065	3,070	98.4	—	+	+	—	—	—

Part B.—Umbilical Cord Stumps Used as an Antigen

Case No.	Sex*	Age, Days	Weight, Gm. At Birth	Weight, Gm. Present	Temperature	Cord Presence	Palpable Glands: Inguinal Right	Palpable Glands: Inguinal Left	Palpable Glands: Occipital Right	Palpable Glands: Occipital Left	Palpable Glands: Axillary Cervical Mental Right	Palpable Glands: Axillary Cervical Mental Left	Blood Reaction	Anaphylactic Tests Inspected Daily for Four Days
108	♂	12	4,130	3,910	98.4	—	+	+	—	—	—	—	—	—
109	♀	8	4,055	4,200	98.6	—	+	+	—	—	—	—	—	—
110	♀	10	2,955	2,640	98.6	—	+	+	—	—	—	—	—	—
111	♂	10	3,450	3,480	98.4	—	±	±	—	—	—	—	—	—
112	♂	9	2,840	2,880	98.4	—	—	—	—	—	—	—	—	—
113	♂	10	3,860	3,840	98.4	—	+	+	—	—	—	—	—	—
114	♂	6	3,300	2,980	98.2	—	+	+	+	—	—	—	—	—
115	♀	12	2,063	2,040	98.6	—	+	+	—	—	—	—	—	—
116	♀	8	3,750	3,510	98.4	—	+	+	—	—	—	—	—	—

* In this Column ♀ represents female and ♂, male.

therefore, could hardly be caused by the sensitization of the infant against attached umbilical cord.

3. The cord stump, however, might contain degenerative products or toxic substances which would cause the inguinal nodes to become swollen. It is known that a toxin can bring about a lymph node enlargement. The effect of diphtheria toxin, for instance, has been studied by several authors. Barbacci [18] and Bulloch and Schmorl [19] come to

18. Barbacci, O.: Ueber die feineren histologischen Alterationen der Milz, der Lymphdrüsen und der Leber bei der Diphtherie-Infection, Zentralbl. f. allg. Path. u. path. Anat. **7**:321 (May) 1896.

19. Bulloch and Schmorl: Ueber Lymphdrüsenerkrankungen bei epidemischer Diphtherie, Beitr. z. path. Anat. u. allg. Path. **16**:247, 1894.

practically the same conclusion, namely, that lymph glands subjected to diphtheria toxin show a decided hyperemia and a high degree of hyperplasia of the gland parenchyma. Benzancon and Labbe [20] state that in an extreme case of glandular intoxication by diphtheria toxin the picture of necrosis predominates and that only in less severe cases or following the injection of diphtheria antitoxin does active reaction set in. Imamura,[21] studying the effects of tissue reactions of lymph glands to exotoxins, endotoxins and mixed toxins, came to the conclusion that the follicles react against free toxin, necrosis occurring; while against endotoxin, irritation and hyperplasia are the rule.

Since a toxic substance, especially a mildly toxic substance, stimulates a lymph gland to hyperplasia, it was necessary to investigate the cord stumps for such a material. Ten dried stumps were collected as they dropped off. They were macerated and extracted in a physiologic sodium chlorid solution containing 0.25 per cent. of tricresol. The extract was then titrated against sheep's red blood cells, the dilution of one-fifth being selected for the antigen. Blood was taken from nine babies (Table 8). The infants ranged from 6 to 12 days of age, eight of them having palpable inguinal glands. Anaphylactic tests were performed upon the babies using the Pirquet technic, the tuberculin being replaced by a drop of the extract. Complement fixation tests were made upon all the blood specimens, the newly prepared antigen being used. In all cases both blood tests and anaphylactic tests were negative. The enlargement of the inguinal lymph glands, therefore, could not be due to toxic substances in the cord stump.

4. The remaining cause of lymph adenopathy to be considered is the absorption of a sterile foreign protein. Practically no data are available concerning the effect of a sterile protein upon lymph glands. Gilbert and Carnot [22] state that occasionally with eruptions and serum therapy one sees a generalized lymphadenopathy explainable only as a reaction against a foreign protein. Further experimentation along these lines is beyond the scope of this paper. By elimination of infection and toxic causes, we feel justified in stating that, in all probability, the inguinal lymph nodes are enlarged because of the removal of the proteins in the cord stump by way of the lymph stream.

This theory, however, does not explain the enlargement at birth of 4.9 per cent. of inguinal glands and 3.95 per cent. of occipital glands.

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20. Benzancon, F., and Labbe, M.: Effets comparés de l'action sur les ganglions du bacille et de la toxine diphtherie, Compt. rend Soc. d. biol. **50**: 507 (May) 1898.

21. Imamura, H.: Ueber die Gewebsreaktion der Milz und der Lymphdrüsen gegen Toxin, Verhandl. d. Jap. path. gesellsch. Tokyo, 1912, p. 65; abstr. Zentralbl. f. Bakteriol. u. Parasitenk. **60**:680 (March 17) 1914.

22. Gilbert, A., and Carnot, P.: Bibliothèque de thérapeutique, Paris, 1909, p. 201.

A survey of the thirteen cases (Table 9) in which swollen lymph nodes were palpated at birth shows that only one case of the thirteen was a premature infant, that the average temperature of the group was 98.4 F. and that, in only two instances, did the inguinal and the occipital glands become enlarged simultaneously. A certain percentage of the palpable glands in this group are undoubtedly due to the delay of one to three hours after birth before palpation of the lymph nodes. Lippman [10] has shown that a sudden and marked leukocytosis occurs in the first few hours after birth. Immediate palpation of the newborn infant would eliminate lymph node enlargement which might be due to this leukocytosis. The data of Jensen, which were determined immediately after birth, also show 7.5 per cent. of palpable occipital glands. He connects no pathologic significance to the findings of these glands and expresses his doubt that they have any connection with an

TABLE 9.—PALPABLE LYMPH GLANDS AT BIRTH

Index No.	Right Occipital	Left Occipital	Right Inguinal	Left Inguinal	Weight Lb.	Weight Oz.	Temperature
9	+	0	0	0	6	5	98.0
41	+	+	+	0	7	1	98.6
64	+	0	0	0	8	5	99.0
75	+	0	0	0	8	5	98.0
79	+	0	0	0	6	6	98.0
86	+	+	+	+	7	9	98.8
21	0	0	+	0	6	15	98.2
29	0	0	+	0	6	6	98.0
39	0	0	+	0	8	10	99.0
67	0	0	+	+	4	5	97.6
76	0	0	0	+	6	15	99.6
77	0	0	0	+	7	2	....
78	0	0	+	+	6	7	97.6
Total	6	2	7	5	(Av.) 7	0	98.4

hereditary constitutional anomaly. He points out that the glands were present in a case of cesarean section immediately after the extraction of the child and that this disproved the theory of traumatic or infectious origin in the birth canal. A small percentage of infants at birth show enlarged inguinal glands for which the etiology is as yet unknown.

CONCLUSIONS

1. Daily curves of the percentage of lymph node enlargement show three distinct types: (*a*) the inguinal type which increases steadily from about 8 per cent. on the first day of life to 58 per cent. on the seventh day and then falls gradually to 48 per cent. on the eleventh day; (*b*) the occipital type which increases slightly from 6 per cent. on the first day to about 16 per cent. on the fifth day, descends slightly and then makes a sharp ascent to 25 per cent. from the ninth to the eleventh days, and (*c*) the cervical type which follows no definite course but oscillates between 0 and 4 per cent.

2. Occipital and inguinal lymph nodes are palpable at birth to the extent of 3.95 per cent. and 5.9 per cent., respectively. No cervical, axillary, mental or cubital glands, however, can be felt at birth.

3. Mental, cubital and axillary lymph glands were not palpable in any case throughout the entire series.

4. The high percentage of palpable axillary lymph glands found by Coerper and Baer was, in all probability, the result of identifying as a lymph node the head of the humerus or a nerve trunk.

5. The factors of sex and circumcision and the presence of moist cord stumps have no influence upon the incidence of lymph gland enlargements.

6. The factors of infected eyes and jaundice may have a slight correlation with the palpability of lymph glands.

7. Certain other factors associated with lymph node swellings of the new-born infant may be enumerated in the order of their importance thus: (*a*) infection of the nasal and pharyngeal passageways which causes most or all of the palpable cervical glands, (*b*) prematurity which is correlated with the presence of a higher percentage of palpable inguinal, occipital and cervical lymph nodes, and (*c*) high temperatures (above 100 F.) which are associated, to a slight extent, with the involvement of cervical and inguinal glands.

8. One tenth of the inguinal lymph nodes which are palpable in the new-born can be accounted for by the factors of infection, prematurity, temperature, jaundice, sex, circumcision or the presence of a moist cord stump.

9. One fifth of the occipital glands which are palpable in the new-born can be accounted for by the factors of infection, prematurity, high temperature, jaundice or infected eyes.

10. All of the cervical lymph nodes which are palpable in the first two weeks of life are caused, in all probability, by oral, nasal and pharyngeal infections.

11. The enlargement of inguinal lymph nodes is not due to infection.

12. The new-born infant develops no antibodies against the attached umbilical cord.

13. The new-born infant is not sensitized against the disintegrating proteins of the cord stump.

14. The new-born infant shows no toxic reaction against the foreign proteins of the cord stump.

15. A large percentage of inguinal lymph node enlargement is due, in all probability, to the absorption of sterile foreign protein from the dry cord stump.

BOOK REVIEWS

PELIDISI-TABLE. By CLEMENS PIRQUET, M.D. Vienna and Leipzig: Josef Safàr, 1921 (English).

The table contains a short note describing how the nutrition index Pelidisi is obtained and how it can easily be found in the table when the sitting height and the weight of the child are known. The table is very useful. The sitting height is given in centimeters; the weight, in kilograms.

PRINCIPLES OF PROFESSOR PIRQUET'S SYSTEM OF NUTRITION. By EDMUND NOBEL. Pp. 15, with 1 illustration. Vienna and Leipzig: Josef Safàr, 1921 (English).

In this short treatise are given the principles of the Nem (Nutrition Element Milk) evaluation of diets, as well as the nutritive value of various foodstuffs, raw and cooked, and examples of how to plan suitable diets.

ANOMALE KINDER. By L. SCHOLZ, M.D. Third edition, revised by Adalbert Gregor, M.D. Pp. 312. Berlin: S. Karger, 1922.

The book deals with the limits of mental health in children. "Anlage," heredity, degeneration, the causes of mental deficiencies, their somatic foundation and accompaniments are discussed. Various forms of feeblemindedness are described. Nervousness, hysteria and epilepsy are treated in separate chapters. Another chapter is devoted to chorea minor, for no very apparent reason. The sixty-four pages in which are considered the psychopathic children are perhaps the most interesting ones; but a discussion of the various groups into which these children are divided would exceed the limits of a review. The disturbances of the period of puberty and dementia praecox, with its two main divisions—hebephrenia and katatonia, are considered. The heading of one chaper is "Suicide." The pathologic basis of suicide is strongly emphasized. In the chapter on prophylaxis, the necessity of the prevention of marriage of unsuitable individuals is duly stressed and the necessity of complete abstinence from alcohol is emphasized unduly. Nearly one fourth of the book deals with various forms of treatment and welfare measures. A philosophic vein makes the book very attractive to many readers.

KURZES LEHRBUCH DER KINDERKRANKHEITEN. HEINRICH LEHNDORFF, M.D. Second edition. Pp. 276. Vienna and Leipzig: Josef Safàr, 1922.

A rather liberal use of small print enlarges the scope of the book considerably beyond the limits of such abbreviated textbooks whose *raison d'être,* on the whole, is somewhat doubtful to the pediatrician. It is questionable whether such remarks as, "A dysfunction or hyperfunction of the thymus may be concerned with the sudden death in cases of status thymicolymphaticus," deserve even small print at this time. The abnormal thrombocytolysis in the reticulo-endothelial system as a factor in morbus maculosus werlhofii might be better established before its admission to the text. Some chapters, such as that on asthma and enuresis, need revision even for a short textbook. On the whole, the book is superior to the majority of similar short textbooks.